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AUTOMATION AND TECHNOLOGICAL CHANGE

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ECONOMIC STABILIZATION

OF THE

JOINT COMMITTEE ON THE ECONOMIC REPORT

CONGRESS OF THE UNITED STATES

EIGHTY-FOURTH CONGRESS

FIRST SESSION

PURSUANT TO

SEC. 5 (a) OF PUBLIC LAW 304

79TH CONGRESS

OCTOBER 14, 15, 17, 18, 24, 25, 26, 27, AND 28, 1955

Printed for the use of the Joint Committee on the Economic Report

U.S. Congress [illegible] report

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CONTENTS

Statement of— Page

- Astin, Dr. A. V., Director, National Bureau of Standards 571
  - Appendix 587
- Barton, William W., president, W. F. & John Barnes Co., Rockford, Ill 243
- Beirne, Joseph A., president, Communications Workers of America; accompanied by William Dunn, assistant to the president, CWA, and Sylvia Gottlieb, research director, CWA 335
  - Attachments 350–364
- Brockwell, Harold D., and Thomas G. Dill, members of the executive council of the International Plate Printers, Die Stampers, and Engravers Union of North America, AFL 419
- Brunetti, Cledo, director, engineering research and development; accompanied by A. A. Brevaire and W. H. G. Fitzgerald 365
  - Charts 389–397
- Buckingham, Walter S., Jr., associate professor, Georgia Institute of Technology 29
- Burgess, Robert W., Director, Bureau of the Census, Department of Commerce; accompanied by M. H. Hansen, Assistant Director for Statistical Standards, and James L. McPherson, machine development officer, Bureau of the Census, Department of Commerce 72
- Bush, Dr. Vannevar, president, Carnegie Institution of Washington 604
- Carey, James B., secretary-treasurer, CIO, and president, International Union of Electrical Workers, accompanied by Nat Goldfinger, associate director of research, CIO 219
- Cordiner, Ralph J., president, General Electric Co.; accompanied by Ray H. Luebbe, vice president and general counsel, and Robert L. Fegley, public relations services division 423
  - Charts 435–443
- Coughlin, Howard, president, Office Employees' International Union, AFL 213
- Cross, Ralph E., executive vice president of the Cross Co 492
  - Prepared statement 502
- Davis, D. J., vice president—manufacturing, Ford Motor Co 51
- Diebold, John, president, John Diebold Associates, Inc 6
- Elstrom, Alden, president, Alden Elstrom Associates, Minneapolis, Minn 642
- Hollengreen, M. A., president, National Machine Tool Builders' Association 590
- Hursh, S. R., chief engineer, Pennsylvania Railroad Co 543
- International Plate Printers, Die Stampers, and Engravers Union of North America, AFL 419
- Kennedy, W. P., president, Brotherhood of Railroad Trainmen; accompanied by Dewey Anderson, director of the Public Affairs Institute of Washington, and Emil Zuklin, secretary to Mr. Kennedy 454
- McPherson, Edwin M., Lester B. Knight & Associates 636
- Mitchell, Don G., chairman and president, Sylvania Electric Products, Inc 169
- Mitchell, James P., Secretary of Labor; accompanied by Ewan Clague, Commissioner, Labor Statistics 262
- Mobley, M. D., executive secretary, American Vocational Association, Inc 643
- Munce, Marshall G., vice president, York Corp., York, Pa 397
  - Charts 408–411
- Nance, J. J., Studebaker-Packard Corp 416
- Nourse, Dr. Edwin G., former Chairman, Council of Economic Advisers 618
- Phalen, Clifton W., president, Michigan Bell Telephone Co.; accompanied by Henry Crampton, assistant vice president 515
  - Prepared statement 530
- Powers, Frank B., public relations consultant 418
- Pragan, Otto, director, research and chemical education, International Chemical Workers Union 151
  - Prepared statement 164
- Reams, Clinton August, president, Reams Research & Development, Inc., New York, N. Y 421

Statement of—Continued Page

Reuther, Walter P., president, Congress of Industrial Organizations, accompanied by Don Montgomery, director, Washington Office, United Automobile Workers of America, and Nat Goldfinger, associate director of research, CIO, Washington, D. C. 97
Snyder, John I., Jr., president and chairman of the board, United States Industries, Inc 564
Tait, Robert C., president, Stromberg-Carlson Co.; senior vice president, General Dynamics Corp 197
Walsh, Thomas J., chemical group director, automation project; professor, chemical engineering, Case Institute of Technology, Cleveland, Ohio 474
  Prepared statement 488
Weiss, Margaret C., president, Maryland Telephone Union, Inc 640

Additional information:

Advertisement in Railway Age (October, 1955) 458
Announcement and schedule of hearings 2
Answers to questions asked of the Pennsylvania Railroad Co 560
Automatic Manufacturing Plant—Mass Production Shop of the Future, reprinted from Machinery, February 1946 253
Average number of production workers in metalworking machinery 1927–53, and in machine tools, 1919–53 85
Case study of a company manufacturing electric equipment (October 1955) 279
Condensation of the book, Automation 14
Electrical manufacturing employment declines, despite high level output 1953–55 225
Electrical machinery production and workers in the industry, comparison, 1947–55 223
Estimated farm population in the United States, 1910–55 88
Growth of electronics industry, 1940–65 181
Introduction of an electronic computer in a large insurance company (October 1955) 290

Letters:

Heberton, K. W., Western Union Telegraph Co., to chairman, October 27, 1955 600
Humphrey, Hon. George M., Secretary of the Treasury, to chairman, October 26, 1955, transmitting Treasury Department press release of September 23, 1955 635
Patman, Hon. Wright, to Hon. George M. Humphrey, Secretary of the Treasury, October 24, 1955 271
Phalen, C. W., president, Michigan Bell Telephone Co., to chairman, November 9, 1955 526
Rahn, W. A., chairman, executive committee, Washington Plate Printers Union, local No. 2, International Plate Printers, Die Stampers, and Engravers Union of North America, AFL, to chairman, October 24, 1955 270
Ruttenberg, Stanley H., director, department of education and research, Congress of Industrial Relations, to chairman, November 9, 1955 147
Notes toward an economic study of automation, by John Diebold, John Diebold & Associates, Inc., New York, N. Y 10
Parts fabrication conventional or numerical 209
Production workers in machinery industries and in all manufacturing industries, 1899–1953 82
Questions asked of the Michigan Bell Telephone Co 525
Railroad industry today compared with 25 years ago 469
Railroad work losses 471
Ranking of durable goods manufacturing industries by 1940–50 percent change in employment 91
Ranking of major industry groups by 1940–50, percent change in employment 91
Ranking of nondurable goods manufacturing industries by 1940–50, percent change in employment 92
Ranking of transportation industries by 1940–50, percent change in employment 92
Section on automation taken from a report to the UAW-CIO Economic and Collective Bargaining Conference, November 12, 1954 139
State of the art of automatic data-processing machines 587
Trends in output per man-hour and man-hours per unit of output, manufacturing, 1939–53 301

LIST OF TABLES

Page
Average annual percent change in output per man-hour and man-hours per unit of output, manufacturing by type of index, 1939–47 and 1947–53 314
Average annual percent change in output per man-hour, manufacturing, selected periods, 1909–39 313
Average annual percent increase in real private product per man-hour 319
Bell System (A. T. & T. Co. and its principal telephone subsidiaries) (excludes Cincinnati & Suburban and Southern New England Telephone Cos.) 358
Change in production, physical output per man-hour and unit man-hours, manufacturing, durables and nondurables, 1939–47, 1947–53 314
Class A telephone carrier employees—by types of workers, percent in each class, 1945–53 361
Class A telephone carrier, overall change in employment between 1945 and 1953 361
Chemical, petroleum:
  Hours worked and income 491
  Number of employees in relation to all manufacturing 481
Chemical plants employees and value of manufacturing 490
Data used in measuring production 321
Data used in measuring production by industry groups 322
Dial conversions—Michigan 363, 364
Dial telephones—Bell System, 1921–54 362
Dial telephones, percent of—Bell System 362
Durable goods manufacturing industries, ranking of, by 1940–50 percent change in employment 91
Electrical machinery production and workers in the industry, comparison 1947–55 223
Electrical manufacturing employment 1953–55 225
Employment in all manufacturing and in chemical industry 166
Employment in communication equipment and related products industries, 1947–55 289
Farm population in the United States, estimated, 1910–55 88
Indexes of net output per man-hour, unit man-hours, production, and man-hours, manufacturing, 1939 and 1947–53 315
Indexes of physical output per man-hour, unit man-hours, production, and man-hours, manufacturing, durable- and nondurable-goods industries, 1939 and 1947–53 315
Industrial production index 166
Labor force growth 108
Labor turnover rates in radio, phonograph, television sets, and equipment industry, 1950–55 288
Life-insurance personnel, growth of in the United States, 1948–53 300
Major industry groups, ranking of, by 1940–50 percent change in employment 91
Nondurable goods manufacturing industries, ranking of, by 1940–50 percent change in employment 92
Physical output indexes of production, 1947–53, industry coverage in terms of 1947 production worker employment 321
Production indexes, comparison of 333
Production workers, average number of, in metalworking machinery, 1927–53, and in machine tools, 1919–53 85
Production workers in machinery industries and in all manufacturing industries, 1899–53 82
Railroad industry today compared with 25 years ago 469
Railroad job losses, estimate, 1947–55 471, 472
Railway payroll costs per thousand trailing gross ton-miles 561
Refineries, number and capacity 489
Rfinery and petroleum industry employees 489
Telephone calls per operator, 1921–54 360
Telephone calls per operator, 1921–54 (by index number, 1921=100) 360
Transportation industries, ranking of, by 1940–50 percent change in employment 92
Weights used in combining products in industry indexes 323
Western Electric Co. employees, 1920–54 358

LIST OF CHARTS

	Page
A. T. & T. Co. share owners	541
Average annual earnings, General Electric employees	442
Average earnings in manufacturing	390
Bell System employee earnings	540
Bell System plant investment	541
Bell System share of national employment	538
Bell System telephones, increase in	534
Civilian labor force	393
Dial telephones, proportion of	532
Electricity, home use of	438
Electricity, sales of in the United States	437
Electricity used by average worker (annually)	438
Electronic production process	392
Electronics industry, growth of, 1940–65	181
Employee compensation and benefits (General Electric)	442
Employees of Bell System telephone companies	538
Employed versus unemployed	394
Employment, farm and nonfarm	408
Employment, growth in, total, 1939–55—country—General Electric	441
Employment, service industries and retail distribution	393
Employment, total, in electrical industry	439
Employment, total, in specific industries	392
General Electric employees	441
General Electric prices versus commodity prices, raw material costs, and employment compensation	439
Gross national product	396
Gross national product, trends in, 1955–75	182
Jobs increase with labor-saving improvements	410
Long-distance conversations	535
Man-hours per unit of output, all manufacturing, 1939–53	313
Mechanization partially offsets the effect of higher wage costs on price	411
Millions of job changes every month	409
Our growing economy	389
Our growing workload	395
Output per man-hour, all manufacturing, 1909–47	311
Output per man-hour, all manufacturing, 1939–53	312
Parts fabrication conventional or numerical	211, 212
Payments for materials and supplies (General Electric)	443
Payroll of Bell System telephone companies	540
Population—labor force and gross national product	396
Price reductions in General Electric consumer products	440
Production workers in machinery industries as percent of production workers in all manufacturing industries, 1899–1953	83
Proportion of households with telephone service	535
Railroad job losses, estimates of, 1947–55	473
Residential electricity, cost of, 1900–1954	436
Residential electricity, cost of versus cost of living	437
Return on equity (for owners of General Electric)	440
Telephone calls per operator 1921–53	359
Telephone rates in relation to other prices since 1935	534
Telephones and gross national product	536
Telephones and population	536
Wage and salary employees	397

AUTOMATION AND TECHNOLOGICAL CHANGE

FRIDAY, OCTOBER 14, 1955

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC STABILIZATION OF THE
JOINT COMMITTEE ON THE ECONOMIC REPORT,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Wright Patman (chairman) presiding.

Present: Representative Wright Patman.

Also present: William H. Moore, staff economist; Grover W. Ensley, staff director; and Reed L. Frischknecht, consultant to Senator Watkins.

The CHAIRMAN. The subcommittee will come to order.

The Joint Committee on the Economic Report, in its consideration last winter of the President's Economic Report, was impressed with the importance of continually increasing industrial productivity. The full committee accordingly directed this Subcommittee on Economic Stabilization to study the impact of so-called automation on long-run employment and investment levels (S. Rept. 60, 84th Cong., 1st sess., p. 6). Increasing productivity has provided a self-generating force for economic good in the past. In the interests of economic stability and growth, we must be alert to long-run trends and make sure that it continues that way, with its good features maximized and the resultant personal and short-run hardships, if any, kept at a minimum.

The interest which the full committee expressed last winter, and which prompts these hearings, has since grown by the week and month as the newspapers, Sunday supplements, and magazines report ever new and startling developments in automation. The frequency with which not only the trade magazines but the mass-circulation popular magazines have devoted articles to this subject is striking indication of the public concern as to its economic and social implications. "Blessing" or "curse" seems to be the type of question which these articles seek to answer.

The plan for the subcommittee's study of automation and technological change is perhaps best summarized in an announcement of the hearings which was issued last Monday. A copy should be inserted in the record at this point, to be corrected for subsequent changes in the schedule and order of appearances.

(The information referred to is as follows:)

CONGRESS OF THE UNITED STATES

JOINT COMMITTEE ON THE ECONOMIC REPORT SUBCOMMITTEE ON ECONOMIC STABILIZATION

HEARINGS ON AUTOMATION AND TECHNOLOGICAL CHANGE

Representative Wright Patman, Democrat, of Texas, chairman of the Subcommittee on Economic Stabilization of the Joint Committee on the Economic Report, today released the list and time of appearances of the witnesses who will appear at the subcommittee hearings on automation and technological development. All of the hearings will be held in room P–63, the old Supreme Court room in the Capitol.

Since the Joint Committee on the Economic Report is charged under the Employment Act of 1946 with the responsibility of making continuing studies of matters relating to employment, stability, and growth in the economy, the subcommittee is interested in such broad economic and social implications of automation as (1) the extent of possible and probable displacement of personnel, (2) the possible shifts and distortions which may arise in the distribution of mass purchasing power, (3) the equitable distribution of the expected gains in productivity, (4) the effect upon our business structure, (5) the effect upon the volume and regularity of private investment.

Using the term "automation" broadly to include various new automatic and electronic processes, together with rapid technological advances, the committee plans to develop its information primarily through a series of case studies of selected industries. In each of these cases, persons who have had experience from the standpoint of management and labor in the particular industry have been asked to present concrete, specific, case-study information.

Exigencies of scheduling have in some instances made it impossible to hear all witnesses in respect to a given industry on the same or succeeding day. The accompanying schedule is accordingly presented in chronological form as well as in more detail form by topics and affiliations of the witnesses.

Industrial witnesses have been asked to discuss the cost and other considerations which have prompted the trend toward automation in their concern and industry. They have been asked to discuss also the extent of labor adjustments which have occurred as a consequence of automation and to emphasize what future technology may hold in terms of investment and employment levels.

Other questions involve the distribution within the plant of indirect and direct labor; what segments of industry are susceptible to automation; how the gains of increased productivity should be distributed between labor, owners, and consumers; what are the requirements for new worker skills; how can the training and retraining problems best be handled; what are the factors which now limit or slow up the installation of automatic machinery; what will be the effect of the trend toward automation upon the relative position of large enterprises and smaller local businesses?

Spokesmen for labor have been asked to comment upon a similar set of questions, emphasizing especially the impact of the automation movement upon labor, individually and collectively.

Members of the Subcommittee on Economic Stabilization are as follows:

Representative Wright Patman, Texas, chairman

Senator Joseph C. O'Mahoney, Wyoming
Senator Arthur V. Watkins, Utah

Representative Augustine B. Kelley, Pennsylvania
Representative Jesse P. Wolcott, Michigan

Schedule of hearings on automation and technological change

1. WHAT IS AUTOMATION: GENERAL SETTING

Name	Position	Date
John Diebold	Former editor, Automatic Control, author: Automation, the Advent of the Automatic Factory.	Friday, Oct. 14, 10 a. m.
Walter S. Buckingham, Jr	Associate professor, Georgia Institute of Technology.	Do.

2. AUTOMATION IN THE METALWORKING INDUSTRY

D. J. Davis	Vice president, manufacturing, Ford Motor Co.	Friday, Oct. 14, 2 p. m.
Walter P. Reuther	President, Congress of Industrial Organizations.	Monday, Oct. 17, 10 a. m.
William W. Barton	President, W. F. & John Barnes Co., Rockford, Ill.	Monday, Oct. 24, 10 a. m.
James J. Nance	President, Studebaker-Packard Corp.	Tuesday, Oct. 25, 2 p. m.
Marshall G. Munce	Vice president, York Corp.; chairman, industrial problems committee, National Association of Manufacturers,	Do.
Ralph E. Cross	The Cross Co., Detroit, Mich.	Wednesday, Oct. 26 2 p. m.
M. A. Hollengreen	President, Landis Tool Co., Waynesboro, Pa.; president, Gardner Machine Co., Beloit, Wis.	Thursday, Oct. 27, 2 p. m.
John I. Snyder, Jr	President and chairman of the board, United States Industries, Inc.	Do.

3. AUTOMATION IN DATA PROCESSING AND THE OFFICE

Robert W. Burgess	Director, Bureau of the Census	Saturday, Oct. 15, 10 a. m.
Howard Coughlin	President, Office Employees International Union	Tuesday, Oct. 18, 2 p. m.
Ralph J. Cordiner	President, General Electric Co	Wednesday, Oct. 26, 10 a. m.
Allen V. Astin	Director, National Bureau of Standards.	Thursday, Oct. 27, 2 p. m.

4. AUTOMATION IN THE CHEMICAL INDUSTRY

Otto Pragan	Research director, International Chemical Workers Union.	Tuesday, Oct. 18, 10 a. m.
Thomas J. Walsh	Chemical group director, automation project; professor, chemical engineering, Case Institute of Technology, Cleveland, Ohio.	Wednesday, Oct. 26, 2 p. m.

5. AUTOMATION IN THE ELECTRONICS INDUSTRY

Don G. Mitchell	President and chairman of the board, Sylvania Electric Products, Inc.	Tuesday, Oct. 18, 11 a. m.
Robert C. Tait	President, Stromberg-Carlson division, General Dynamics Corp.	Tuesday, Oct. 18, 2 p. m.
James B. Carey	President, International Union of Electrical, Radio, and Machine Workers.	Monday, Oct. 24, 10 a. m.
Cledo Brunetti	Director, engineering research and development, General Mills, Inc.	Tuesday, Oct. 25, 10 a. m.

6. AUTOMATION IN THE TRANSPORTATION INDUSTRY

W. P. Kennedy	President, Brotherhood of Railroad Trainmen.	Wednesday, Oct. 26, 11 a. m.
S. R. Hursh	Chief engineer, Pennsylvania Railroad Co.	Thursday, Oct. 27, 10 a. m.

Schedule of hearings on automation and technological change—Continued

7. AUTOMATION IN THE COMMUNICATIONS INDUSTRY

Name	Position	Date
J. A. Beirne	President, Communications Workers of America.	Tuesday, Oct. 25, 10 a. m.
Clifton W. Phalen	President, Michigan Bell Telephone Co.	Thursday, Oct. 27, 10 a. m.

8. INVESTIGATIONS OF THE LABOR DEPARTMENT ON THE IMPACT OF AUTOMATION

James P. Mitchell	Secretary of Labor	Monday, Oct. 24, 2 p. m.

9. THE PLACE OF INNOVATION AND TECHNOLOGY IN THE FREE ENTERPRISE SYSTEM

Vannevar Bush	President, Carnegie Institution of Washington.	Friday, Oct. 28, 10 a. m.
Edwin G. Nourse	Former chairman, Council of Economic Advisers.	Do.

ORDER OF APPEARANCES

Friday, October 14:
- 10 a. m.:
  - John Diebold, former editor, Automatic Control; author, Automation, the Advent of the Automatic Factory.
  - Walter S. Buckingham, Jr., associate professor, Georgia Institute of Technology.
- 2 p. m.: D. J. Davis, vice president, manufacturing, Ford Motor Co.

Saturday, October 15:
- 10 a. m.: Robert W. Burgess, Director, Bureau of the Census.

Monday, October 17:
- 10 a. m.: Walter P. Reuther, president, Congress of Industrial Organizations.

Tuesday, October 18:
- 10 a. m.:
  - Otto Pragan, research director, International Chemical Workers Union.
  - Don G. Mitchell, president and chairman of the board, Sylvania Electric Products, Inc.
- 2 p. m.:
  - Robert C. Tait, president, Stromberg-Carlson Division, General Dynamics Corp.
  - Howard Coughlin, president, Office Employes International Union.

Monday, October 24
- 10 a. m.:
  - James B. Carey, president, International Union of Electrical, Radio, and Machine Workers.
  - William W. Barton, president, W. F. & John Barnes Co., Rockford, Ill.
- 2 p. m.: James P. Mitchell, Secretary of Labor.

Tuesday, October 25:
- 10 a. m.:
  - J. A. Beirne, president, Communications Workers of America.
  - Cledo Brunetti, director, Engineering Research and Development, General Mills, Inc.
- 2 p. m.:
  - James J. Nance, president, Studebaker-Packard Corp.
  - Marshall G. Munce, vice president, York Corp.

Wednesday, October 26:
- 10 a. m.: Ralph J. Cordiner, president, General Electric Co.
- 11 a. m.: W. P. Kennedy, president, Brotherhood of Railroad Trainmen.
- 2 p. m.:
  - Thomas J. Walsh, chemical group director, automation project; professor, chemical engineering, Case Institute of Technology, Cleveland, Ohio.
  - Ralph E. Cross, the Cross Co., Detroit, Mich.

Thursday, October 27:
  10 a. m.:
    Clifton W. Phalen, president, Michigan Bell Telephone Co.
    S. R. Hursh, chief engineer, Pennsylvania Railroad Co.
  2 p. m.:
    John I. Snyder, Jr., president and chairman of the board, U. S. Industries, Inc.
    Allen V. Astin, Director, National Bureau of Standards.
    M. A. Hollengreen, president, Landis Tool Co., Waynesboro, Pa.; president, Gardner Machine Co., Beloit, Wis.
Friday, October 28:
  10 a. m.:
    Vannevar Bush, president, Carnegie Institution of Washington.
    Edwin G. Nourse, former Chairman, Council of Economic Advisers.

The CHAIRMAN. As pointed out in this release, the subcommittee is proceeding with its study largely through a series of case studies. We plan to cover briefly the metal-working, data-processing, chemical, electronics, transportation, and communication industries. We have selected these industries as illustrative of the kind of problems which may be faced in the trend toward automation. There are, of course, many, many other industries which might have been studied with equal interest and profit had time permitted. The fact that we have chosen these particular industries and in most cases the associated unions should not for a moment obscure the fact that we also have rapidly advancing technology in other areas. To mention a few, one might cite the canning and bottling industries. One might cite petroleum refining, the processing of commercial bank paper work, the basic steel industry, the use of ready-mixed concrete, the use of electronically controlled elevators in our modern skyscrapers, and many others.

No study of automation would, of course, be complete without recognition of the important and overwhelming role which technology and scientific thinking play in the development of our instruments of defense. This defense use will always be in the background but, since the joint committee's primary interest in this respect lies in civilian employment and the civilian segment of the economy, we shall not take up defense applications except in an indirect way.

Here it may be desirable to point out for the record several changes which have been made in the schedule of appearances since it was first publicly released.

Mr. M. A. Hollengreen of the Landis Tool Co. and Dr. A. V. Astin, Director of the National Bureau of Standards, will appear on the afternoon of October 27 instead of October 17.

Two other witnesses experienced in the design and creation of metal-working and transfer equipment—Mr. William W. Barton of the W. F. & John Barnes Co., Rockford, Ill.—will appear on Monday, October 24, at the morning session; Mr. Ralph E. Cross of the Cross Co., Detroit, builders of special machine tools, will appear on October 26.

Marshall V. Munce, vice president of the York Corp., York, Pa., will appear on October 25.

President J. M. Symes of the Pennsylvania Railroad has designated Mr. S. R. Hursh, chief engineer, Pennsylvania Railroad Co., to help round out our consideration of the role of electronics and automation in railroading. Mr. Hursh will appear on the morning of October 27.

We are particularly sorry that Mr. Sheldon Hall, president of the

Office Equipment Manufacturers Institute, will be unable to be with us as we had hoped on October 26 because of very serious illness in his family.

We are particularly sorry about this since the office equipment industry is clearly one of the central areas in the trend toward automation, with their various computing devices and electronic recording machines. Through the widespread publicity and advertising given these thinking "robots," capable not only of taking over the traditional manual efforts on the part of human beings, but capable of injecting some substantial measures of memory and of even "thinking" processes, they have naturally captured the public imagination.

Some of these machines have even undertaken to predict election results and left their friends trying to explain that the machines never make errors—only the human beings who control them. One of these machines, called Erma—which might well sound like a hurricane to those affected—has recently been getting a lot of publicity because it can reputedly do the chores of 50 bank clerks.

Having read the advertisements of companies in this industry with their promises of labor saving and displacement, we, of course, tried to get representation from this industry by asking to hear from several of the leading companies, and finally, their trade association—the Office Equipment Manufacturers Institute. While Mr. Hall personally has our sincere sympathy and understanding, we are sorry that no other spokesman for this important industry could be found, even by the institute's executive committee. Perhaps if there is another or future occasion to hold hearings on this subject, we can get one of these thinking, computing, data-processing machines to be on hand to speak for itself.

Turning now to the participants at this morning's hearings, I understand, Mr. Diebold, that you have recently given up the editorship of the magazine Automatic Control and that Mr. Harry D. Wulforst is now the editor.

Your book, Automation, the Advent of the Automatic Factory, has, of course, been one of the best known in the field. I have read the address which you gave at the 1-day conference convened under the auspices of the Congress of Industrial Organizations last April, and have heard reports of a speech which you made earlier this week at the special conference on automation, sponsored by the American Management Association.

I understand that you are also the president of John Diebold & Associates, Inc. For the record I wonder if you could tell us a little bit about the activities of this company.

STATEMENT OF JOHN DIEBOLD, PRESIDENT, JOHN DIEBOLD & ASSOCIATES, INC.

Mr. Diebold. At the present time I am devoting all of my energies to the practical application of automation to American industry through the management consulting firm of John Diebold & Associates, Inc. We are a firm of consulting management engineers, specializing in the field of automation as applied to both the office and the factory. The growth of this firm during the past year and a half has been very substantial. With 16 people on the payroll we are now the largest—and I believe quite widely recognized as the leading—management engineering firm specializing in the field of computers and automation.

Specifically, we are engaged in the business of putting automation to work for the benefit of our clients—American firms ranging in size from the very largest corporations to the very small. We are familiar with almost every major automation program in this country, and provide counsel on the engineering and technical aspects of automation as well as the organizational and managerial aspects. Although we develop the engineering specifications for automation equipment, we do not design or manufacture the equipment itself. I think that this should answer your question, as far as defining the scope and nature of the activities of John Diebold & Associates, Inc.

Is it your intention that I proceed?

The CHAIRMAN. You may proceed in your own way, sir.

Mr. DIEBOLD. I would like to say it is a privilege to be here, sir. I think all Americans welcome the initiation of these hearings, and the attempt to derive some factual information about automation and its impact upon the economy. I think it is a curious paradox that the more we talk about automation, the less confidently we can assume a common understanding of the term. The word has come to mean so many things, to so many people, that (for the moment at least) it seems in danger of losing a great deal of its usefulness. Automation has become an issue and as a result is too often discussed with less regard for the facts than for the particular preoccupation of the speaker.

We have heard automation characterized variously as a potential threat to the national economy; as a key to increased leisure opportunity; as a mystical pseudoscience of robots and giant brains; and as a press-agent's description of automatic operation, from the kitchen toaster to the subway turnstile. If you follow the progress of Dagwood, you may have noticed that as of this morning Dagwood is faced with possible replacement by an automatic machine. As you have said, automation is certainly capturing the popular imagination, and is being very widely—if not always wisely—discussed.

As I understand it, my mission this morning is to try to make clear some of the characteristics of automation—"the nature of the beast." If I am not mistaken, during the next 2 weeks of hearings you will receive a great many different and conflicting definitions of automation. The most common statement, in this respect, is that automation is merely an extension of mechanization. If this is the case, there certainly seems little justification for a separate new word to describe it.

I think that if the facts are looked to, if what is actually happening at the present time is analyzed, it is possible to come up with a particular set of changes that are occurring in industry and in business that perhaps justify the use of a new word to describe them. It seems to me this is more than simply the introduction of new kinds of hardware, or a particular kind of technology. It is a basic change in production philosophy.

Our original and traditional attitude toward the organization of industrial processes has been to organize our industry according to a division of labor. When we first organized factories and businesses, we found it necessary to break down our work, to allow for a division of labor according to specific human skills. Later, as we mechanized our activities, and introduced machines into factories, we followed the same breakdown, the same division of labor, and we mechanized around that division of labor. We introduced machines into specific departments of plants and into sections of plants to do activities that were organized originally according to the division of labor. Now, through automation—and I think this is perhaps the basic meaning of automation—we are beginning to look at our industrial processes as complete, integrated systems, from the introduction of the raw material until the completion of the final product. This may be a physical product, or (in a business process) it may be information. We look at this as an integrated system, and we try to weld together the parts of that system in order to optimize the use of our resources—the human resources and material resources and capital resources that are being used to produce the end product. It seems to me this is basically a change in production philosophy. It is something analogous to Henry Ford's concept of the assembly line. It is a way of looking at, as much as it is a way of doing, a technology.

One way of defining automation is to say that it is a means of organizing or controlling production processes to achieve optimum use of all production resources—mechanical, material, and human.

There are two basic steps that industry follows in the approach toward automation. The first of these is the organization of each of the several steps of the production process into a fully integrated system. The oil refineries pioneered in this step; the chemical industry, processing industries, and nuclear production have since followed in going through this first step of automation. They have changed what had formerly been batch processes into integrated systems.

The second step of automation is to take the system and to control it in such a way that it operates at optimum all of the time. I think there has been a great deal of confusion upon this point, and you may very well see this reflected in some of the statements during the course of the hearings. People who are not familiar with the process industries will point to oil refineries and say: "This is automation. Other industries are going to develop in the same way." Actually, by the introduction of control systems into oil refineries and other processing industries—paper manufacturing, sugar refining, chemical manufacture, etc.—a second stage of automation is being achieved. Here it is not a case of replacing hand labor by machines, but rather of operating the machines at optimum efficiency all of the time.

I think it is possible to characterize the nature of automation by three simple statements: First, the concept of automation is very simple. It is a welding together, as I have said, of the production steps. It is looking at production processes as closed and integrated systems. Secondly, the technology of automation is incredibly complex. It is easily among the half dozen most advanced technologies of our time. Fundamentally, it deals with the transmission and use of information for the purposes of machine control, and for the purposes of optimizing production. I think you may be interested in the origin of this technology. The individual use of self-regulating mechanisms—devices that can regulate the course of their own activity—is very old. It goes back to the float-control valves the Romans used, and devices used by the early Dutch to keep windmills facing into the wind. James Watt devised a regulator, the "flyball governor," to keep his steam engine operating at constant speed, and there have been a number of other uses of this concept of self-regulation, which is known as feedback.

During World War II, the theory and use of feedback was studied in great detail by a number of scientists in this country and in England. The introduction of rapidly moving aircraft very quickly made traditional gun-laying techniques of antiaircraft warfare obsolete. It was impossible to follow such rapidly moving targets manually. As a result, a large part of the scientific manpower in this country was directed toward the development of self-regulating devices and systems to control our military equipment. It is out of this work that the technology of automation, as we understand it today, has developed. During the last 10 years, this technology has begun to be applied to industry. Yet it is not so much the technology itself, but rather the way it is applied, that is properly called automation.

I think the third point about automation that may help to give an understanding of its nature is that its application is very widespread. Automation can be applied in many types of businesses and industries. If automation is regarded as a philosophy, a way of organizing production, it is something that can be applied in areas where only a small amount of actual mechanization is possible. It seems to me that a good example which will clarify this point is the automation of office procedure. We have developed, through the use of the new technology, the machines you mentioned in your introduction: Computing machines and data-processing equipment. Through the use of this equipment it is possible to automate office operations which hitherto have been conducted entirely by hand.

In the factory, automation means basically two things: It means, first of all, the integration of production machines, which may in fact be no more than a new level of mechanization. An often-cited example is the Ford plant in Cleveland, where injection blocks are made quite automatically by the use of a series of special-purpose machines—an automatic mass-production line.

Most of American industry, however, depends upon short runs of product. About 89 to 90 percent of all American production is in lots of less than 25 individual pieces. It is impossible to build special-purpose machines to manufacture these, because the character of the product changes too frequently. This is where the second meaning of factory automation comes in. In such a job-shop operation automation is just beginning to be achieved, in the form of tape-controlled machine tools—machines for which instructions can be provided in a flexible and variable form. This kind of automation is just beginning to have an impact. It gives every impression of taking a very long time to come about.

All of these facts about the nature of automation—and I am sure you will hear many more during the next few weeks—are different aspects of what is basically a single new philosophy, and a single new technology.

What does all of this mean to the economy? Fundamentally, I think automation means an optimization of our business and industrial activities. For example: A paper-pulp mill may operate considerably below the optimum point for a large part of the time. It will only be for a very short period after the regulating devices have been manually set that such an operation will make full use of the material resources that go into it. With automation, it is possible to introduce self-regulating control systems. Instead of operating at optimum, at the best relationship of all the variables—and in the process industries there may be thousands—for only a few minutes a day, it is going to be possible to operate at optimum for most of the day. Here, obviously, the introduction of automation is not justified by decreases in labor costs; it is justified by increasing the utilization of capital investment, by increasing the utilization of the raw materials.

Such "automated" equipment operates 168 hours a week, rather than 40 hours a week. It makes possible better utilization of capital equipment, higher productivity, a greater rate of return. Call it what you will, what it amounts to is less capital investment per individual unit of output. I think there are a number of facts about the economics of automation that have been very superficially approached, and I am sure that some of these will be brought out in the hearings.

I think that this represents one of the very important and good reasons for holding such hearings. A great deal of factual study must be undertaken. I think that you will make clear the need for such a study by these hearings. A more detailed and comprehensive analysis of what precisely is happening in various industries—an extension of the case studies that you plan to undertake during these hearings—is, I think, called for to make clear to all concerned—and we are all concerned—the real nature of automation, and its effects.

It seems to me the key to the economic impact of automation is the rate of speed at which it is introduced. If the changes of the last 50 years had been compressed into the space of 2 or 3 years, we would have witnessed economic chaos. If the changes of automation took place overnight, we would undoubtedly have reason for concern. I don't believe that is going to happen. I think that this, too, is something that will be brought out during the next few weeks' testimony.

It take a long time to effect automation. A reorganization of our business and industrial processes is a very difficult and lengthy business. My own firm is directly in this field, and I can speak from substantial experience. It takes a long time to bring about such changes.

I think that an assessment of the actual rate and extent of automation is called for. I would like to introduce into the testimony an outline of a factual study of automation that I have prepared for your use as background material.

The CHAIRMAN. Do you desire to insert it in connection with your remarks?

Mr. DIEBOLD. Yes, sir, if I may.

The CHAIRMAN. You may do so.

(The above material is as follows:)

NOTES TOWARD AN ECONOMIC STUDY OF AUTOMATION

By John Diebold, John Diebold & Associates, Inc., New York, N. Y.

In my previous remarks, I have attempted to describe what automation is, and how it is currently being applied in American business and industry. For the past several years there has been a great deal of discussion about the impact of automation, but with regard to the fundamental economic issues involved, this discussion has been largely conjectural. To my knowledge, no economic study has yet been undertaken to discover precisely how automation affects the structure of industry, the labor force, and human relationships. The significance of automation is widely recognized, and has been conscripted to service in more than one cause: yet of the precise nature of that significance little has been said, for the quite simple reason that little is known, in a comprehensive, quantitative sense.

THE NEED

The problem, in assessing the economic and social impact of automation, is that we do not have the facts. If there is concern over the effects of automation, it seems to me highly desirable that we get these facts in the most expeditious way possible: through a thorough analysis of automation, based on a complete, factual, industrywide investigation. Such a study would provide, for the first time, a realistic basis for planning on both a national and private scale. With the broader perspective such a study would provide, industry could plan automation policy with a finer regard for the consequences. National policy concerning education and training programs, retirement benefits, and unemployment compensation must be based upon such a factual and intimate understanding of the subject.

The following is an outline of what seem to me the major economic questions raised by automation. No attempt is made to suggest the answers to these questions: The purpose of this brief statement is to suggest the broad issues and to indicate a number of specific questions of special significance.

THE MAJOR ISSUES

Obviously, the most fundamental issues are those raised by the following questions:

How does automation affect the stability of employment?

What are the implications of automation for economic stability?

The answers to these questions obviously depend upon the answers to a great number of specific questions concerning the extent and rate of automation within a given industry, and within individual firms. It has been frequently suggested (indeed, it is the basis for labor's campaign for the GAW) that automation in a given plant or industry tends to reduce the stability of employment. Though we should be foolish to rule out this possibility as an assumption of the proposed study, there is reason to believe that precisely the opposite may be true.

Automation implies a decrease in direct labor and an increase in capital costs. Traditionally, when in depressed circumstances, firms have tended to maintain prices and decrease production—and consequently employment. In an automated firm, however, with the consequent decrease in direct labor and increase in capital costs (which must be carried regardless of the level of output) adjustment may very well be different. The advantages of labor layoffs will be less apparent, and output will more likely be maintained, because of fixed capital charges. As a result, changes in demand will, in all likelihood, affect prices rather than output and employment. Thus greater stability of employment is seen to be a likely consequence of automation.

Other questions which seem to me to be of primary significance are:

How does automation affect the relative income shares of capital and labor?

How are wages in automated industries altered relative to wages in nonautomated industries?

What is the process by which wage increases (or other benefits) in automated industries spread to nonautomated industries?

How does this affect interindustry competitive relationships? (i. e., are there examples of companies forced to close all or part of their production facility because of inability to meet higher wage rates in an automated industry, or are these increases passed on in higher prices?)

I believe it is generally recognized that productivity is determined by technology (although it may be expressed in labor terms). According to traditional distribution theory, returns to the factor of production under competition are determined by their marginal productivity. This is, of course, quite theoretical, but it raises the interesting question: How is it possible to determine the marginal product of labor when (as in a highly automated industry) most of it is indirect? Remove a single maintenance man from a highly automatic process, and production may be forced to stop. Does this mean (as the marginal productivity theory implies) that the entire product must be attributed to a single worker?

Nor is it much more useful to talk in terms of the marginal product of capital, because the same amounts of money invested in different types of equipment may have very different productivities. The marginal productivity theory assumes the homogeneity of capital, and I believe it is commonly recognized today that capital is far from homogeneous. In this sense, a great part of economic theory seems, at this point, in need of some rethinking. Automation simply makes the need more obvious.

The questions which must be answered, in this regard, are:

> What is the significance of traditional marginal analysis when (as in a highly automated industry) there is a great shift from direct to indirect labor? (i. e., how can any product be identified with any individual worker?)
>
> What does it mean to talk about the productivity of capital when capital is nonhomogeneous?

I believe it is becoming increasingly clear that the effects of automation concern not only questions of productivity and employment, but in fact the very way we regard these questions—that is to say, the nature of economic theory.

HOW SUCH A STUDY MIGHT BE PERFORMED

It seems to me that there is, at this point, only one useful way of collecting, organizing, and analyzing the information necessary to such a study as that which I have proposed: a detailed case-by-case approach to a number of specific industries which are regarded as typical of the several kinds of automation practiced today. The schedule of industry and labor spokesmen to be witnesses to these hearings indicates, it seems to me, that the members of the committee also consider such an approach valuable—although for the purpose of a factual study, of course, a much wider sampling would be required.

There are a number of organizations—foundations, Government agencies, universities, private consulting firms—qualified to conduct such a study at the present time. Since the subject seems to fall naturally into certain divisions of major significance, the study itself might well be similarly divided among a number of specially qualified agencies. I should certainly think that some sort of Government sanction, official or otherwise, would prove an enormous advantage in obtaining the information required.

A great deal of the necessary information might be elicited through detailed questionnaires and interviews; a certain part of it, however, would require considerable fieldwork by personnel with a background in automation engineering. A likely approach would be to work, at least in the beginning, with the cooperation of automatic equipment manufacturers and engineering consultants who have worked in automation.

Beyond the general issues I have already raised, I should like to suggest at this point a number of more specific questions which represent the kinds of information which should be gathered for such a study. For purposes of simplification, I have chosen to divide these questions into a number of impact areas: obviously no such division actually exists; whatever affects industry affects labor, and in turn, the entire community. By such arbitrary division I mean only to indicate the nature of the questions involved.

I. Automation and industry

Answers to the key questions below must be sought by analyzing developments within particular industries.

A. What industries are using the techniques of automation?

B. How are these techniques being applied? What degree of the total production capacity may be described as automated?

C. How rapidly is automation being introduced? When did the industry (company) first begin consciously to automate? What current technological or economic development might affect the rate and/or degree of automation?

D. To what extent (in a given company) does automation permit the manufacture of goods or the performance of services not possible otherwise? To what extent does automation permit production of goods and performance of services now possible but with less labor and/or less capital? (See F-3.)

E. What industries not highly automated could be so, if present technological advances were applied? What has prevented the introduction of automation

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in these industries? Within highly automated industries, what companies have conspicuously not automated? What are the reasons given? How many companies avoid automation because they cannot afford the initial investment? Because they don't want to take risk?

F. How is industry structure being affected?

(1) Is there a tendency toward greater centralization or decentralization?
  (a) Geographically?
  (b) Administratively?
(2) How is company organization affected?
(3) Will expansion or contraction be the more likely results?
  (a) What is the nature of cost savings made possible by automation?
  (b) How are these savings reflected in pricing policies?
  (c) How does the market respond to a lowering in prices?
(4) What happens to competition?
  (a) As a result of high capital requirements?
  (b) As a result of optimizing productivity?
  (c) As a result of patents?

(5) What is the prevalence of merger unions in automated industries as compared with nonautomated? How has automation affected the current trend toward product (or service) diversification?

(6) What changes in power and natural resource demands has automation caused?

II. Automation and labor

Because the effects of automation vary not only from industry to industry, but also from firm to firm, labor implications must be distilled from case studies analyzing specific instances.

A. In individual industries (company by company) how is employment affected?

(1) What change in total employment (of automated segment) of direct labor? Indirect?

(2) What particular job skills have been made obsolete?

(3) What new job skills are required?

(4) What proportion of new job skills can be easily acquired by workers with obsolete skills?

B. How does automation affect the level and structure of wages?

C. How does automation affect job equity?

D. How are industrial-relations policies and hiring policies changed?

E. What are worker attitudes toward automation?

F. How has automation affected collective bargaining?

G. How has automation affected working conditions (Safety? Machine pacing? Increased responsibility? Improved work area?)

H. How have union jurisdictions been affected?

I. How has internal union organization changed?

III. The automation equipment industry

It has been estimated that in 1954 $3 billion was expended on automation equipment; and that by 1960 the volume will expand to $10 billion. What are the characteristics of this industry?

A. What is the nature of the firms producing automation equipment? What proportion are new firms? Of old firms, how great a part of the total production effort is involved? Does this represent a major diversification? How rapidly have firms expanded in this field? What is the incidence and nature of mergers?

B. What portion of total output is absorbed by military and/or defense needs? What is the role of the Government in purchasing, research, and product development?

C. What is the effect of patents?

IV. Education and automation

Automation greatly increases the need for personnel trained in the design, construction, supervision, and maintenance of automatic equipment. It increases our already urgent need for more engineers, and imposes a special demand for a new kind of engineer—the systems engineer. From top management to the semiskilled production-line worker, automation requires entirely new kinds of training.

A. What are the specific retraining and educational requirements of automation?

B. What kinds of training programs have been undertaken? By firms? By public schools? Private institutions? Unions? Equipment manufacturers?

C. Upon whom should the responsibility and cost of retraining fall? The worker? Company? Equipment manufacturer? State or Federal Government?

D. How has the present supply and quality of engineers and technical personnel affected the degree and rate of automation? Has a shortage of trained personnel discouraged any firms from introducing automation? How has this supply affected the development and production of automation equipment?

E. Does automation increase or decrease the range of jobs for which women are qualified?

F. What specific problems does automation raise for older workers? Is the nature of retraining necessarily too difficult for older workers? Have companies shown an unwillingness to retrain older workers because of the comparatively reduced return?

V. Automation and the community

Beyond the challenge to the community implied in all the previous questions, automation suggests another special question of considerable significance. Labor leaders have consistently cited the shorter workweek as their next objective, after the establishment of the guaranteed-wage principle. J. Frederick Dewhurst, director of the Twentieth Century Fund, has estimated that by 1975 Americans will be working a 32-hour, 4-day week.

A. How will this increased leisure affect consumption patterns? How will this, in turn, affect the growth of service industries?

B. How will this affect the requirements of our transportation, educational, and recreational facilities?

C. Does it imply a need for basic changes in the nature of our primary- and secondary-school training? (I. e., Is it true, as some psychologists observe, that the majority of people in this country are not able to make effective use of increased leisure opportunities?)

The questions raised here are far from comprehensive: the effects of automation are many and widespread. I have attempted only to indicate those areas of change with which, I should suppose, the Federal Government would be most immediately concerned. A study based upon such questions would surely be or enormous value to the Government in planning tax policy, educational appropriations, and pension and unemployment compensation provisions.

I hope that the hearings now beginning will stimulate interest in such a study as I have proposed and believe that the real need for more information upon the subject of automation will become evident in the course of these inquiries. Such a study would go a long way toward reducing the confusion and mistrust which automation seems to have generated among a great part of the public, and I am sure would be welcomed at this point by industry, labor, and the American public itself.

Because it is the only comprehensive account of the subject of automation currently available, I have taken the liberty of inserting at this point, a brief condensation of my book Automation, with a few minor revisions. I believe it will prove a valuable glossary and general reference in connection with the testimony presented at these hearings.

(Text of condensation follows:)

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A CONDENSATION OF THE BOOK AUTOMATION, BY JOHN DIEBOLD

CHAPTER I. THE PROBLEM OF AUTOMATION

The word automation

For a long time I have searched for a definition of automation that would be of use to me in an operational way—as a guide in my everyday task of planning changes in factories and offices. It is difficult enough to define the word in a manner at once precise and comprehensive; it is even more difficult to make that definition useful in narrowing the wide scope of the problem to a workable range. In the course of these hearings, I am sure we will all gain some new insights into the problem. In the meantime, I offer the following for your consideration, hoping only that it will prove as useful to you as it has to myself.

Automation is a means of analyzing, organizing, and controlling our production processes to achieve optimum use of all our productive resources—mechanical and material as well as human.

Whether the product be a cylinder head, a radio receiver, a synthetic fiber or information, it is a concern with the production process as a system, and a subsequent consideration of each element as a part of that system. In planning for automation primary attention is directed toward the system, and the task of integrating the separate elements into the system. The whole problem of production is approached anew—even the product is reappraised in terms of its function and the functions of the machines that handle it.

The idea is not new

Automation is not a new idea—in 1784 Oliver Evans built an entirely automatic, continuous process flour mill just outside Philadelphia. No human labor was required from the time the grain was received at the mill until it had been processed into finished flour, and in 1801 Joseph Jacquard exhibited an automatic loom controlled by punched paper cards, similar to those used in modern office equipment. As the steam age progressed, use of automatic machines increased. By 1833 even biscuitmaking had been mechanized at the British Navy's "victualizing office."

Although some forms of automatic controls have been in existence since early stages of the steam age, until recently development of automatic controls has been sporadic. Automatic mechanisms developed before the last decade generally were designed for performing a limited number of tasks.

Developments of the last decade in the field of electronics, communications and electric network analysis have made possible a wide variety of self-correcting and self-programing machines, capable of automatically performing a sequence of logical operations. They can correct the errors which occur during their own operations and can choose, according to built-in criteria, from among several predetermined plans of action. These are the technical bases on which automatic factories can be built.

Essential elements for developing automatic factories

Although automatic control mechanisms are necessary elements of fully automatic factories, they are not sufficient in themselves. Other elements essential to developing fully automatic processes and factories are:

Product and process redesign.

Analysis of processes in terms of functions rather than steps now being performed.

Rethinking the entire operation.

These are often infinitely difficult problems which, nevertheless, must be solved before business can realize advantages of the Aladdin's lamp which is held forth by technology.

Loose thinking

Much of the published material on automatic processes and factories presents the problem as primarily one of control. Very little has been said about the underlying techniques which are the really important part of these new devices and which can permit design of entirely new industrial equipment.

Furthermore, little published material is available on the changes that must be made and problems that must be solved before electronic circuits and controls can make automatic production possible.

CHAPTER II. CONTROL AND THE COMPUTER

Communications theory and control

The basic contributions of communications theory in the last decade have been the concept of the bit or indissoluble unit of information and an analysis of transmission of these units in the presence of noise. Noise in this sense means disturbance in the meaningful patterns of bits of information during their transmissions.

Simultaneously, and related to these developments in communications theory, has been the development in control theory of stable feed-back or self-correcting control systems for a wide range of uses. These feed-back or self-correcting control systems are also called closed-loop, or servo-mechanism systems. Research in this country and in Britain has developed the closed-loop systems sufficiently so they can conform to rigid performance specifications and operate in a stable manner.

These developments in communication theory and control, plus electric network analysis, have made possible electronic digital computers which eventually may supplant many functions now performed by human beings in industrial control. It is the perfection of stable closed-loop control mechanisms, as a part of the development of electronic digital computers, which plays the most important as well as the earliest role in automation.

Basic types of automatic control mechanisms

Automatic control mechanisms are of two basic types: open-loop and closed-loop (self-correcting). Both types may possess two characteristics important for industrial control:

1. Control at low energy levels, that is, the energy required to operate the controls need have no particular relation to the energy being controlled. Thus, it is not necessary to build complicated automatic control devices in a form capable of carrying high-energy flows.
2. Control from a distance, that is, the control element can be placed at a great distance, if necessary, from the element being controlled. This, for example, makes possible grouping of all controls of a chemical process plant in one location, so that a fully automatic control system can be built.

The most important control characteristic, however, from the standpoint of automation is the ability to correct errors. The ability to correct errors is the distinguishing characteristic of the closed-loop control system.

Automation is possible only through the use of stable closed-loop control systems capable of a variety of applications.

Open-loop control

The open-loop control is one in which the control mechanism is independent of the performance of the system which it controls. Many "automatic" controls are of this type. For example, street lights which are turned on by a preset mechanism at a specified hour, or hours, operate regardless of natural light conditions. Darkness caused by heavy clouds in the late afternoon, or by fog, will not turn on the lights before the specified hour.

Closed-loop controls

Operation of the control device in the closed-loop system is, in part, a function of the actual performance of the system or machine being controlled. This distinctive feature of the closed-loop control mechanism makes possible the industrial development which has become known as automation.

A thermostatically controlled electric oven is a good example of a closed-loop control system. Such a control will automatically compensate for fluctuations in the electric current, the amount of prior operation and even for opening or closing the oven door. The temperature in the oven will be held within a very small predetermined range.

Human use of machines and tools which have only simple open-loop controls depends on a closed-loop system of control in which the human muscular and nervous systems provide the closing of the loop.

Development of closed-loop control

The earliest application of closed-loop control mechanisms was regulations of the speed of machines, for example, James Watt's centrifugal governor for steam engines.

Another major step in development of closed-loop control systems was remote position control which made its first appearance toward the end of the 19th century in the form of control systems for the steering gear of ships.

Development of closed-loop controls for industry did not really get underway until the decade of the 1930's. In that decade, attention was directed to control mechanisms for oil refining and certain chemical processes. The military demands of World War II, however, gave the greatest impetus to development of electronic servomechanisms (closed-loop control systems). These developments have made possible the design and construction of stable closed-loop control systems capable of performing a great variety of tasks.

The computers

The electric analogue computer and its techniques are most useful for models, or analogues, of industrial processes and for determining the reaction of the system to various operating conditions to which it may not be possible to subject the actual system or process itself, for purpose of experiment. A much publicized "model" of this sort is the model electric power system or grid.

The electronic digital computer relies on the basic arithmetic of addition and subtraction for its operation. By performing a long series of essentially "elementary school" steps in very rapid sequence, it is possible for such a computer to solve highly intricate problems very rapidly. Computers can also compare, collate, and make logical choices between alternatives. But such choices are based upon built-in and alterable instructions, the computer having no semblance of free will.

Mathematical notations and words are both symbols for ideas or quantities. "Word symbols" can be altered to correspond with symbols which a computer is built to handle. Thus, it is possible for computers to handle all types of information.

Most computers are now built to handle binary numbers. Binary numbers are composed of only 2 digits, most commonly 1 and 0, and represent all higher numbers by combinations of these 2 digits. Similar combinations of 1 and 0 can also be used to represent letters of the alphabet. Hence, it is basically no more difficult to handle logical problems represented by word symbols than to handle mathematical problems.

The physical construction of computers varies greatly but functionally they all contain much the same type of unit. These are:

> A computing element which actually processes and compares data or makes a logical choice.
>
> A control element which schedules the sequence of operations and automatically programs the action of the computing unit.
>
> A memory or storage element capable of retaining in permanent or temporary form information necessary for operating the machine.

In addition, there is an input unit, necessary to introduce information into the computer, and an output unit to withdraw and record information from the computer.

Because of the exceedingly high speed at which electronic computer elements operate, at present the real bottlenecks of the computer for business use are the speeds of programing (input) and printing (reporting and recording) units, and limitations of the memory capacity.

To program a computer, for example, it is necessary to know precisely what is required and to reduce the problem to a series of precisely defined, elemental steps. At each stage the machine must figuratively ask a question which can be answered by "yes" or "no," represented in binary form. Many of the decisions we make unconsciously, even when solving the simplest business or production problem, would fill pages when set down in the form of computer programing, with alternative courses of action indicated at each step.

Despite these problems, digital computers provide a means of automatically governing the operation of much of our manufacturing equipment. With processes permitting a continuous flow of product units, completely automatic plants are possible. In even more cases, however, portions but not all of the operations of a business can be put on an automatic basis.

CHAPTER III. THE REDESIGN OF PRODUCT AND PROCESS

Rethinking products and processes essential

Industrial automation brings new problems as well as new solutions. In many cases we must redesign our products, our processing methods, and our machines in order to harvest all the fruits of automation. But to redesign products and processes we must rethink them.

Popular misconception

A widely held misconception about automation is that since all the elements of the automatic factory are already with us, all that remains is to connect the proper instruments to the computer (central control mechanism) and attach our machines. This simply is not true.

Actually, redesign of product, or of process, or of machinery—and sometimes redesign of all three—is usually necessary to take full advantage of the new technology. It is both erroneous and self-limiting to think of the possibilities of automation merely in terms of connecting today's machines to electronic controls and making precisely the same products we make today in much the same way.

There is an enormous difference between a process which merely makes use of automatic controls and a process which is truly automatic. The steel industry is a good example of this distinction. Many automatic control devices are used in steel production but, except for continuous casting, steel production is not automatic. There is, moreover, little likelihood of it becoming automatic regardless of how many electronic control devices we may employ unless we rethink the entire process of steelmaking.

Automatic continuous casting made possible by rethinking the process

In most steel casting mills, the casting procedures used today are essentially the same as processes in use many years ago. Steel men have long hoped and searched for a continuous casting process. But continuous casting became a reality only about 10 years ago, and then only for nonferrous metals.

A continuous brass casting process has been used for some time by Scovill Manufacturing Co. with great success in production of brass castings of uniform cross section.

Republic Steel Corp. and the Babcock & Wilcox Tube Co. were successful pioneers in continuous casting of steel. Actually, after solving major problems by rethinking the process, these companies claim that the steel produced by their continuing casting process is considerably better than steel produced by conventional methods. In addition, the continuous process eliminates handling the steel between the ingot and billet stages.

Redesign of product—Ice cubes

Automation may require redesign of product as well as process. Frequently such redesign will not reduce customer acceptance—it may, in fact, increase saleability of a product. An ice cube designed with a hole in the middle allows fully automatic production and by providing a larger cooling surface, is a better product. The consumer does not object.

Redesign of radio circuits

Printed radio circuits provide another excellent example of a product redesigned for automatic production. By thinking of circuits in terms of their functions rather than their present physical form, it has become possible to redesign the circuit in the form of flat planes. This has made possible the development of a machine for automatic production of radio circuits. As a result, only a small amount of manual work remains (in assembling plates, tubes, and amplifier) to complete the radio receiver.

In developing this machine, John A. Sargrove actually solved some of the basic problems of the automatic factory because his machine allows for product change. A number of different radio receiver circuits can be produced with only slight variations in the mechanism.

Other examples of redesign

Recently Sylvania Electric Product Co. redesigned a miniature amplifier for airplane intercommunication systems to permit automatic manufacture.

The A. O. Smith Co. did notable product redesign work during World War II to mechanize and speed production, among others, of airplane propellers and bomb shells.

Product redesign for ease of manufacture is not limited to automatic production. It has been and is a continuing problem in industry. Product design engineers devote their entire attention to designing for ease of manufacture. For them the idea of redesigning a product to permit automatic manufacture is not new. Good product design engineers are familiar with such concepts as the doctrine of least constraint—a systematic approach in designing component parts to allow maximum freedom in manufacture.

Semiautomatic production a step toward automation

The following experience of one of the country's largest manufacturers of home ranges would be considered an everyday example of product redesign for semiautomatic rather than fully automatic production. A few years ago this company produced a total of 16 style-price variations of ranges. Production runs on any 1 variety were limited to 2,000 or 3,000. Through redesign all 16 variations were reduced to 1 basic body type and style. Distinctions between price lines and styles were made by altering the top without changing the basic body design. Redesign permitted semiautomatic manufacture of a product that had formerly required many manual operations. It also helped bring this product within a price range of many people who had not previously been able to afford it.

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Actually such redesign is more a case of clever simplification and standardization rather than of basic rethinking about the product. Both are important elements, however, in expanding the possible scope of automation.

Rethinking essential to automation

Rethinking is an attitude, a state of mind. It is an ability to get outside of a problem that seems insoluble and approach it in a new and different way. It is a constant reexamination of whether the problems we are wrestling with are really the problems we should be trying to solve. Rethinking is a constant awareness of the end functions of a product or process and a continued questioning of whether those functions can be performed as well or better by making slight variations in it or by making fundamental changes or even changing to a new basis which will permit automatic production.

It could be that rethinking should be extended to the organizational structure of the firm to get maximum benefits of automation. One of the impediments to rethinking of products and processes has been that the traditional division of responsibilities has the effect of localizing the areas in which rethinking is done. Almost by its very nature, however, rethinking (getting outside of a problem) must be done on an extremely broad base—viewing all implications of a problem in the light of objectives of the whole organization.

Unit operations analysis

Systematic analysis of production processes can help greatly in rethinking processes. But a new approach is necessary in such analysis. Processes should be analyzed in terms of their specific functional elements or units, and with particular reference to the functional elements common to the manufacture of several, perhaps dissimilar, end products.

George Granger Brown and his associates at the University of Michigan have made such an analysis of processes in the "process" industries. Unit operations of various processing industries were analyzed to identify functional operational units common to all of them. Extension of this kind of analysis to industries manufacturing discrete product units (contrasting with continuous product flow) would be the basis for systematic, wide-scale approach to automation.

CHAPTER IV. MAKING MACHINES AUTOMATIC

The problem of short-run production of discrete product units

The continuous process industries, such as oil refineries, are already highly automatic. But little attention has been paid to automatic manufacture of discrete units in fabricating industries which do not have long production runs of nonvarying products. A matter of primary concern in the extension of automation is the problem of automatizing the short- and medium-run manufacture of discrete units of product. A manufacturer producing separate product units faces problems far different than does a chemical manufacturer.

Importance of flexibility

Nevertheless, the type of thinking and designing which converted the chemical and oil industries from batch processing to continuous processing could contribute much to the automation of discrete process industries. Many people in industry feel that the most sensible solution to automation would be to build a large, single-purpose automatic machine which would perform every operation necessary to convert raw material into finished product.

Such machines are already in operation in many partially automatic factories—a Coca-Cola bottling plant is perhaps the most familiar example of an almost automatic factory handling discrete product units. Many food processing and packaging plants use highly automatic single-purpose machines of a type similar to the Coca-Cola bottling machine. The textile industry, though not handling discrete product units, provides other examples of single-purpose, automatic machines.

Fully automatic, single-purpose machines, however, are suited only to a very special case, the case of an extremely large run of a nonvarying product or of an only slightly varying product. They lack the flexibility needed for short- and medium-run manufacture of discrete product units.

Flexibility is the major factor to be weighed in determining whether the large single-purpose machine is the real answer to a more widespread use of automation in the manufacture of discrete units. Many of the widely publicized automatic and partially automatic factories depend upon inflexible single-purpose machinery which is not suitable to medium- or short-production runs. Elements essential to the flexibility needed for the automatic factory are, however, present in today's factories. These elements are the automatic and flexible materials-handling and machine-loading devices.

For medium and short runs, flexibility is essential. Only when the problem of automatic production of medium and short product runs is solved will automatic control mechanisms be used to fullest advantage and on the widest scale.

New approach to machine design

Eric W. Leaver and John J. Brown have proposed a new approach to the problem of automatic production for medium- and small-run plants. This involves designing machines in terms of functions to be performed rather than in terms of predetermined end products. The similarity of approach in the Leaver-Brown proposal and the unit operations analysis of George G. Brown is striking and stems from similar type of rethinking of the whole problem. Moreover, Leaver and Brown come close to the heart of the automation problem in attacking it by means other than the large single-purpose machine.

But the Leaver-Brown approach is not entirely practical in industries such as metal working. A better solution of the problem would be, perhaps, to continue thinking in terms of functions but to think of groups of related processing functions. In many fabricating operations a clearly definable group of functions is usually performed on a related group of products. This comes down to something much like our present-day production machines.

Production machines the middle stage of development toward automation

Production machines are the middle stage between hand-operated and fully automatic machines. Production machines perform a series of machinery functions semiautomatically. Examples of this type of machine are the chucking machines, automatic screw machines, automatic milling machines, and automatic drilling, boring, and grinding machines. These machines perform a certan group of operations upon a product within a limited range of size variations.

In designing flexible machine units for the automatic factory, the starting point would be a group of functions commonly performed on a class of product. If the automatic machine problem for medium-sized runs of product could be solved by means of automatic machines similar to our present-day production machines, we would have the beginning of a reasonably flexible and automatic factory.

Then, if we could couple a group of production machines, or similar machines, designed around the group-of-functions-concept, by some form of inexpensive, automatic flexible materials-handling equipment, and add a control mechanism to do the work normally done by the operator, we would have a factory completely automatic in terms of direct operation although there would still be need for considerable indirect labor.

It is possible to build automatic flexible materials-handling equipment necessary to make an automatic factory economical for short production runs. Similarly, control equipment with necesary flexibility can also be built. The most important single factor in designing such equipment is to think in terms of end functons. The greatest pitfall to avoid is assuming that the design aim is reproduction of the hand movements of the operator or laborer in existing setups.

Automatic machine loading

Many semiautomatic machine-loading devices are already in operation. In designing automatic machine-loading devices for the automatic factory it is simpler to design them to perform the same function in a new and different way rather than mechanically to reproduce hand motions. Again, thinking in terms of functions is necesary.

Flexible materials-handling equipment

For fully automatic plants some type of flexible and universally adaptable materials-handling equipment will be necessary. To be economical, the application of the continuous-flow concept to the discrete unit processes requires flexible materials-handling equipment that can be easily purchased rather than specially designed. Standard conveyor equipment is already available. What is lacking is adaptable standard equipment for lifting, turning, and precise positioning of product units of varying use. Equipment of this sort is now custom built.

Ford Motor Co. has done much to apply the continuous-flow concept to production of discrete product units, and at Ford the production machines are connected by automatic materials-handling equipment. However, these machines are not flexible. Other pioneers are Chrysler Corp. (De Soto engine plant) and General Electric Co., through equipment designed and built by C. F. Hautau.

The synchronization of a series of machines is not unique to an automatic factory; this problem exists in any production line. But in an automatic factory the synchronization of the machines and of the machine output is critical. For an automatic factory it is vital that a continual and uninterrupted rate of progress be established and sustained. It is also necessary, for precise synchronization, to check constantly on the rate of output of each machine or group of machines. This function will ultimately be handled by the small digital computer. Simple, direct, interlocking controls can be used. They are already in use in a number of plants, such as the automatic automobile body frame plant of A. O. Smith Corp., the engine lines of De Soto and Ford.

The crux of the problem, of course, is to devise inprocess inventory handling equipment flexible enough for medium-sized runs. The essential needs are (1) adaptable conveyor or carrying devices that can handle a number of differently shaped products and that need not be custom built; (2) similarly flexible hopper, bin, and machine-feed units mass produced and adaptable to products of different sizes.

An existing automatic factory

The ordnance plant at Rockford, Ill., built by W. F. & John Barnes Co., is an automatic factory producing discrete product units. There are several manually controlled operations used in this plant, and further automation is possible at these points, but it is, nevertheless, an automatic factory. Notable points are the advanced use of flexible materials-handling equipment for inprocess inventory and use of console controls to monitor the central loading device and the turning operations.

Central-control mechanism

One of the most promising industrial applications of the new technology of control, not tried at Rockford or any other plant, is replacement of individual machine-tool controls by a central-control mechanism. This need not wait for perfection of low-cost computers or automatic flow of materials from machine to machine. Grouping the control circuits of individual machine tools in a central-control mechanism can produce substantial savings in many plants as they exist today. It is simply a matter of using control devices more efficiently by using them in a new way. Such adaptation of existing machine tools, however, should be considered a transitional step toward automation.

Individual machine control

Development of stable, closed-loop (or feedback) computers opens the way to increasing flexibility in automatic controls of machines. As the design of stable electronic feedback control systems becomes more thoroughly understood, it will be possible to build machines whose patterns of operations can be controlled automatically by an easily altered set of instructions governing every aspect of the machine's operation.

The problem of automatically varying a machine's operation has been approached in two ways: (1) in terms of providing instructions by punched paper or magnetic tape and translating these into movements of various parts of the machines by servomechanisms, or small motors, and (2) by developing copying mechanisms, which actuate the machine tools through a sensory device that follows the contours of a finished workpiece or model.

Examples of automatic machine controls

For example, some time ago the Arma Corp. in New York demonstrated an automatic lathe controlled by a punched paper tape. In 4 minutes, this lathe machined a workpiece which required 30 minutes when made by an engine lathe operated by a skilled machinist referring to drawings. Tolerances were held to 0.0003 of an inch. Only 15 minutes were required to punch the tape.

A simple electrical, rather than electronic, machine-tool control will be manufactured and sold by Olin Industries. It can be applied to any number of standard machine tools. The hand controls normally used by the operator are simply fitted with small servomotors.

The General Electric Co. in its record playback control records magnetically the actual motions of a machine tool when operated by a skilled machinist. Individual differences between machines would, of course, require that a separate tape be made for each machine being controlled. This poses obvious limitations to use of the device in its present state of development. But record playback control offers a very good solution to the problem of the short run of product. It means that automatic operation of machine tools is possible for the job shop—normally the last place in which anyone would expect even partial automation.

A new family of machines

These developments in automatic controls of existing types of machine tools—essentially machine tools designed for manual operation—indicate the potentialities of electronic controls and the practical realizability of automation. Typically, the introduction of any new technology such as feedback first brings attempts to apply it to the present way of doing things.

The most productive use of closed loop or feedback is in design and construction of entirely new types of automatically controlled production machines. The new technology also has much to offer toward the automation of those areas of industry in which mechanization has made least progress—machine setup, materials handling, product inspection, and assembly. Closed-loop controls also have much to offer toward automation of the office. It is clear that industrial automation will not be complete until all these functions have been made automatic. That will require rethinking the product or function, the process, even the machines themselves, to get optimum results from the new technology.

CHAPTER V. AUTOMATIC HANDLING OF INFORMATION

Information the basic material handled in office operation

In the office the basic material being handled is information. As business grows more complex the need for more and better up-to-the-minute information grows almost in geometric progression. As an index of the increasing burden of gathering and transmitting information which comprises office operation between 1920 and 1950 there was a 53-percent increase in the number of factory workers against a 150-percent increase in the number of office workers. This is also an index of the great need for mechanization of office operations.

Linking plant and office

The new closed-loop or feedback servomechanisms promise more than merely mechanizing office operations, important as that may be. Actually, the new technology opens the way for directly linking office and factory, headquarters and branch offices. With proper analysis and rethinking of requirements and functions much of the routine manual recording of production data, recopying, transmitting and eventually transferring it to punched cards should be eliminated.

This chapter suggests the kind of basic analysis necessary for automation of office operations and for making possible the close linking of office and plant, or headquarters and branch offices. It has already been pointed out that 100 percent automation may be impossible or uneconomical in some present procedures. But automatic performance of the same function in a different way may be entirely possible.

Specially designed machines

For example, the automatic message accounting system developed by Bell Telephone Laboratories represents automation of a complicated paperwork operation. The device, in connection with the dialing system, will eliminate the need for long-distance operators and for their clerical work.

Development of standard electronic machines

Considerable research has been done on standard-type small electronic computing machines suitable for office use. Both IBM and Remington-Rand have developed small electronic computers or calculators as control units for punched card office machinery. The computers provide automatic programing for office machinery and speed up many normal accounting procedures. They are being used for rapid handling of income-tax returns, compilation of payrolls, determination of stock balances, sales and price and many other complex accounting procedures. When properly used such equipment has greatly speeded accounting operations and often has halved the time by which accounting and statistical reports are placed in the hands of management.

Both computers illustrate the way in which standard but flexible functional units can be individually adapted to varying needs of users.

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In addition to the large companies mentioned above, there are many small companies currently offering computing equipment suitable for business use. Many of these are listed in this book and reference is made to other sources for additional listing.

Analyzing Office procedure

The need for skillful and careful analysis of office procedures as a basis for computer programing is recognized by all who have given serious thought to the business use of computing mechanisms. Every action, every decision must be reduced to a series of simple, logical steps which, properly coded, will be meaningful to the computer. The more detailed the original programing analysis, and the more alternatives permitted in the original programing, the easier is the task of introducing new data.

Much has been done, by computer manufacturers, to train and aid potential business users of such equipment in analyzing and programing office operations. But there has been little recognition of the fact that the computer and computer techniques make possible an entirely new approach to the information-handling problems of business. Rethinking of information-handling and processing operations is necessary to get maximum benefits from new technological developments.

Unit operations analysis

Our clerical procedures have been designed largely with reference to, and in terms of, human limitations. The new closed-loop computing mechanisms offer freedom from those limitations. But freedom from those limitations require procedures analysis and creative thinking which will classify processes in terms of elemental functional units common to various operations. Only such analysis will permit an entirely different way of handling business information with the new type of machines.

The office of the future

In a great many instances, the office of the future will receive information gathered and transmitted directly from the point of operations generating the data.

Production scheduling and production controls will be entirely automatic. The way has already been paved for this development. Electronic computers not only will compile the process data now being processed by punched-card systems, but they will also determine optimum scheduling of all production machines. This can be done on the basis of criteria already programed for the machine.

A machine you can purchase today

Lest all this seems too unreal, there is a computer available to industry costing $15,000 (at the time the book was written) for determining production schedules and operators' pay allowances. Although now being used to schedule production for manually operated, semiautomatic machines, it performs the same basic tasks as will be performed by the production planning portion of the central computing mechanism of the automatic factory.

Automatic ordering and inventory control

With automatic information-handling equipment the machine can simultaneously produce lists of required materials as production runs are determined. With proper programing of the machine these requirements can be automatically reproduced on requisition forms.

Taking physical inventory on an automatic basis is less feasible because there is no foreseeable development likely to be realized in the near future which will allow physical counting of assorted items to be placed on a fully automatic basis. The answer would, therefore, be some probability measure to adjust for pilferage and other changes in inventory due to causes other than authorized withdrawals or acquisitions.

The problem of exceptions or the special case

Exceptions to routine of a fully automatic plant or office need not make necessary a duplicate set of paper records. Legal requirements can be met by microfilming original documents. Auditors will be able to make use of computer circuits as they now make use of punched card systems. With proper programing it is entirely possible that all of the information stored in the machine can be available to management on a nonrecurring basis.

Tube failure

Tube failure and power failures are occurrences of normal operations of electronic computers. They need not disrupt operation or erase all record of them. First, it is possible to use preventive maintenance with tubes. Power failure can be offset by arrangements currently in use in many plants and institutions.

As transistors replace vacuum tubes, the problem of failure will be greatly diminished.

Human errors occurring in introducing information into computer circuits are at least as serious as problems of tube failure. Yet the system can be designed to minimize the consequences.

Introducing information into the computer

This is one of the very real and critical bottlenecks to wider industrial use of closed-loop electronic computing circuits. These computers are useful partly because they operate at very high speed—the speed of electricity. Their effectiveness is materially reduced if information must be introduced at the speed of humans and if information cannot be taken from the circuits except by slow typing and printing.

The real problem is to eliminate the need for the typist. Much experimental work is being done in the direction of a mechanism which could read a letter or invoice or parts list and automatically code the information into the computer. Considerable progress has already been made. An experimental model Analyzing Reader has operated at the very slow speed of one character per second with an approximate error rate of 4 percent. It is expected that the commercial model will operate at speeds exceeding 100 characters per second.

More useful information for management

Businessmen whose desks and briefcases are already crammed with information they do not have time to digest are likely to shudder at the prospect of the new technology providing much more information. But the computer can be used to make many comparisons now made by executives in analyzing statistics and they can help management get away from wanting more information since they can facilitate more meaningful planning and consideration of alternative lines of action. The computer can answer the "What would happen if * * *?" questions that cannot now be answered. Computers can analyze and report end results of projected operations set up by management according to various hypotheses or alternatives.

But before computers can be used eeffectively for such analytical or other business functions, considerable analysis must be made of the nature and role of information in modern business. What is needed is analysis in terms of (*a*) whether the information originates outside of the firm or is generated by internal operations and (*b*) the functions common to the processing and use of different kinds of information—similar to unit operations analysis. The sort of analysis of information requirements is not easy and involves many conceptual problems.

CHAPTER VI. WHAT WILL AUTOMATION MEAN TO BUSINESS?

Some specific questions

Questions frequently asked about the specific import of automation on business are: Can small business take advantage of automation? How will the increasing importance of engineers change their status within the firm? What about labor displacement? What chance is there to automatize when a firm's labor is organized?

General answers to these questions have little real meaning; the specific circumstances surrounding each case—the economic and political environment, the people concerned—will determine the applicability and effects of automation in each case. Yes, the fact that automation is not new, but a continuation of a long trend means that we can learn by observing industry and its course during the last generation.

Labor resistance

Perhaps the most pressing problem growing out of automation is that of labor resistance. When automation makes obsolete a specific human skill it works a hardship on the individual laborer who is displaced. In these cases automation will be vehemently opposed. Yet, there is a growing realization on the part of businessmen that some of the responsibility for retraining and restoring the earning power of displaced workers lies with management as well as with the worker. Recognition of the problem, acceptance of a fair share of responsibility for working out a cooperative solution and establishing good management-labor relations will do much to ease the knotty labor problem involved with automation.

The role of engineers

In the face of existing shortages in the supply of engineers, automation will tend to increase still further the demand for engineers and it may well speed the placement of engineers in more general management positions. This will place a further burden on our educational system. More than ever, engineers must be given the basis for increased social understanding of the business context in which they work. This understanding must be far more thorough and acute than is possible to develop on the basis of the customary "survey" courses frequently required for engineers in current curricula.

What future for small business?

With reference to effective analysis of small firm's operating procedures and changes necessary to make theirs suitable to automatic installations—past and present practice in the capital goods industry indicates that some assistance will be available from equipment manufacturers. In addition, reliable consulting firms can do much of the analysis required.

Actually, developments such as the General Electric record playback give promise that automation may well enhance the competitive and relative position of small companies.

Industrial concentration

Will automation strengthen the trend toward industrial concentration for reasons other than research and development problems? Will the capital requirements of automation be so great that the small manufacturer will not be able to afford an automatic plant?

On the basis of past experience the answer to these questions is at least a qualified "no." Furthermore, electronic control devices and computers are already available at prices that most businesses can afford, assuming they can put the machines to productive use and do some financial planning.

The fact, moreover, that automation requires less direct labor means that automatic plants need not be placed in concentrated labor markets.

As flexible automatic equipment is developed it will be possible for smaller concerns to operate very effectively in competition with, or as efficient suppliers to, large companies.

One problem, not confined to small companies, demanding early attention, lest it hinder effective and rapid technological advances promised by automation, is the tax treatment of corporate depreciation. Current depreciation allowances hinder effective and rapid technological growth of our corporations.

CHAPTER VII. SOME SOCIAL AND ECONOMIC EFFECTS OF AUTOMATION

It is clear that any technological development such as automation will have important economic and social repercussions. A reasonable analysis of the probable changes which will result from automation should be preceded by answering two important questions:

How far will automation progress?
How fast will it take place?

The gist of the chapter is that it does dispute the extravagant claims of certain writers. It urges sound thinking and writing about the effect of technological change on human society and deplores predictions of debasement of the human race.

Limiting factors

Automation will not progress as far as the proponents of a completely automatic society have predicted.

The most reasonable expectation is that medium to long runs of similar products will be susceptible to automatic or largely automatic production.

The new technology will allow the development of new kinds of individual automatic or semiautomatic machines, but the product will still have to be moved from one machine to another. It is unlikely that automatic materials-handling systems can be employed economically unless a reasonably long run is expected.

The use of a device similar to General Electric's record playback control may make it possible to extend automation to many job-shop operations, but the gains do not promise to be as great as with other "taping" procedures.

Automation will be limited where human interaction is of primary importance as in distribution, service businesses and in professional fields.

Automation and employment

Automation can and will seriously affect employment in those fields in which it is practicable, particularly certain areas of manufacturing. But manufacturing does not account for the major portion of our employment. Further, automation will be possible only in some of the manufacturing industries and, even in these, a large number of workers will still be needed. Automatic factories will not be workerless factories. Many hundreds of maintenance men will be required.

Repetitive office work, when in sufficient volume, will probably be put on a partially automatic basis. Very few offices will be entirely automatic. Even in the most automatic factories and offices, taping the machines, in addition to maintenance, will require many people. Furthermore, such day-to-day work as answering correspondence and personal calls will still require humans.

Wholesaling and retailing

In distribution, where human intervention is of primary importance, automation will be limited to specific areas of application. An excellent example is in the field of automatic retailing. Examples are given.

Magnitude and rate of change

It is difficult to predict how far automation will progress either with respect to its effect on employment or the number of firms that will use automatic equipment. Yet the types of industry least likely and most likely to be seriously influenced by automation can be suggested.

Although they will use automatic machines, agriculture, trade, service, construction, mining, and the professional field will not be automatized.

The field of industry most susceptible to automation are: bakery products, beverages, confectionery, rayon, knit goods, paperboard containers, printing, chemicals, petroleum refining, glass products, cement, agricultural machinery, miscellaneous machinery, communications, limited price retailing. These industries employ only about 8 percent of the total labor force.

The labor shifts that could be expected from these changes and the time span during which they are likely to occur will probably be no greater than the population shifts which occurred during the 1940's. This comparison emphasizes the fact that the nature and the rate of population shifts due to automation will be of a magnitude with which we are able to cope.

Automation must be viewed in proper historical perspective as a new chapter in the continuing story of man's organization and mechanization of the forces of nature. It raises new problems. It solves some of the problems, human as well as mechanical, that were raised by earlier phases of mechanization.

Debasement of the worker?

Perhaps the most vehement objection to industrial use of automatic controls—and indeed any form of mechanization—is the charge that machines debase the worker still further. But when the condition of labor in today's plants is contrasted with the condition of labor in the past, the burden of proof is surely put on those who decry modern industrial development.

Although automation will bring its own problems, it provides the answer to the human problem of machine pacing and subordination of the worker to the machine.

Automation makes possible machine performance of the repetitive work of industry. The worker will be released for work permitting development of his inherent human capacities.

The work, under automation, which will require the most manpower will be semiskilled and highly skilled maintenance, repair, and operation. Such work is fully within the ability of most people who today work at the simply repetitive tasks of the assembly line, provided they are properly trained and motivated. The maintenance and repair jobs will require a different set of abilities than are needed for engineering and design. A high level of theoretical comprehension is not so important in these tasks as are genuine interest in the work, desire to do good work, and ingenuity.

In an odd and entirely unexpected way, automation may bring us back to the human and phychological values of the self-respecting craftsmen whose alleged demise the professional mourners decry by wailing and bawling "debasement."

Mr. DIEBOLD. The need to assess the rate of speed and the need for factual information is, I think, very pressing at the present time. Automation is too much of an issue. There is too much loose talk about what it means. I think a close and hard look at the facts is called for. It seems to me that one of the facts about automation that should be emphasized is that it makes possible new levels of achievement. It is possible to do new things. This has been the case, I think, with all of our mechanization and all of our industrial development. I think it should be recognized in the case of automation. For example, we could not have our atomic program if it were not for self-regulating controls. No human could operate hand controls deep within the central part of the reactor. It would be difficult to have such simple materials as polyethylene (the material from which "squeezing bottles" are made) without self-regulating controls. The precision must be so exquisite in the manufacture and timing of many such chemicals that it is impossible to manufacture them at all without self-regulating systems of control, without automation.

In the office it is possible to achieve a much higher level of control of operation, to know much more about what is happening, to cut down on the waste of our natural resources by the use of automation. It is a means of optimizing production. It makes it possible to do things that you could not do before, in addition to doing the things we have been doing more efficiently.

It seems to me that the education requirements posed by automation are very important, and I hope that that is one of the areas that you will question very aggressively during the next few weeks. The requirements for education are twofold. Most obviously there is a need to train people in this new field. The type of work that people will be doing is changing. The nature of jobs continually changes, and automation is merely introducing a new set of requirements for the particular kinds of skills that will be needed over the course of the next 20 years. I think it is important that we study these factors, project, and forecast requirements to see that our education system matches these requirements and turns out people for the kind of world in which they will live, rather than for the kind of world in which their teachers have been living.

It seems to me the second requirement for education raised by automation is that automation is very clearly going to increase the leisure time that we have. This has been going on for many years. It is going to continue, and it may continue at an accelerated rate. We are very clearly going to have an increased amount of leisure. I think considerable attention must be given to our education system to see that we use this leisure creatively, that it is used in a manner that benefits all of our society.

I think there is a question of whether automation requires any special legislation, whether it is necessary to establish a particular set of controls, because of automation. My answer to that would be I do not think it is. I think that automation emphasizes, underlines, and perhaps makes more important, a number of the economic conditions that already exist in the country. It clearly makes changes, for example, in the manner in which businessmen decide upon their level of output. If you have a high investment in machinery, and you are faced with the question of cutting down on your output, I think it is an interesting question to raise, whether the depreciation charges on the machinery may not far outweigh the direct charges of continuing to produce. This may be a factor against cutting down and fluctuations in output. I think there are obviously many complex economic problems in this area. I have tried to outline some in the document I submitted for the record.

There are many things that business can do in areas where automation does mean a change in employment. In specific instances where automation would mean a shift of workers to other types of jobs, it is very clear that considerable care should be given to the manner in which automation should be introduced. I have tried in my earlier remarks to indicate that this is not universally the case. There are many areas where you do new things with automation and you are not simply replacing jobs. You are replacing activities that people have done before. However, where you are mechanizing operations that have been done by hand, it is obviously very important to coordinate the hiring policies of a firm, to see that individuals do not bear the brunt of these changes.

A considerable reappraisal by business of the procedure for introducing automation, is, I think, going on in many firms. I am personally acquainted with very few cases where there have been any layoffs due to automation. It has been primarily a case of people shifting their type of job within a firm, and in many cases, of course, there was considerable advancement and increase in the number of people in the operation in order to make use of the new equipment.

A number of basic questions are posed by automation, questions of economic theory, the way we measure productivity. Is it meaningful any more to measure productivity in terms of direct labor if the direct labor content in manufacturing is decreasing? A reappraisal of our traditional economic distribution theory seems to be called for, in the light of the change in these factors.

The very impact of automation on cost accounting, on the methods that we use for distributing costs within a firm—there are many management areas where automation is introducing changes in our concepts, our ways of thinking about management. The organizational structure of business is starting to shift. If you can concentrate the data processing of a business in one area, if you can change the speed with which you can get information, you begin to change the organizational structure of a business. This makes for many changes in the requirements of what people are doing in firms. It again calls attention to education, and to the areas where it is necessary to understand precisely what is happening.

Automation will have some impact on underdeveloped areas. I think that is an area that should be studied. A final point I would like to make is the question of the nature of working environment of individual workers in a plant or office. Mechanization introduced the machine pacing of workers. I think this has been brought out in many cases. There have been a number of studies of why there are psychological problems and unrest on the part of workers engaged in mass production operations. It is, to a large degree, machine pacing—workers having to keep up with machines. Automation changes that environment. It is no longer a question of the machine pacing the man in his job. Instead of a man putting a part in the machine and having the machine do the actual work and the man then taking the part off, we are doing this automatically. You change the character of the job. You put more emphasis on maintenance, on jobs that are less routine, and more fulfiling.

I think there are many other important questions raised by automation, but I would like to stop my presentation at this point to answer any questions that you may wish to ask.

The CHAIRMAN. Mr. Diebold, if it is satisfactory with you and Professor Buckingham, I wish you would just keep your place there and let Professor Buckingham come around and after he concludes you can ask each other questions if you would like and we would also like to ask each one of you questions.

Mr. DIEBOLD. Fine, sir.

The CHAIRMAN. One question I had in mind is about the relative importance of automation on small busines and big business, the work length, and length of hours of week and things like that.

I would like to withhold them until Professor Buckingham has given his statement, so that you gentlemen can each one ask questions and also we would like to ask questions.

Professor Buckingham, associate professor of industrial management at the Georgia Institute of Technology, is one of the several persons on this program who also spoke at the CIO national conference on automation last April.

The subject of the paper which he delivered at that time dealt with the industrial significance of automation. Since the significance of this movement to the present and future of our economy is precisely the interest of this subcommittee, I am sure that Professor Buckingham's remarks will help us to get the general setting of the problem before going into the various case studies this afternoon and during the next 2 weeks.

Professor Buckingham?

STATEMENT OF WALTER S. BUCKINGHAM, JR., ASSOCIATE PROFESSOR, GEORGIA INSTITUTE OF TECHNOLOGY

Mr. BUCKINGHAM. Thank you, Mr. Chairman. I also welcome the opportunity to appear before this subcommittee, and add what I can to the statements which have been made and will be made in the future.

I think it was Oliver Wendell Holmes who once said that, to be learned, one must study, to be alert, one must speak, to be exact, one must write.

I think there is a great need for precise and quantitative thinking in this field, and this is what has prompted me to submit a written statement, which I hope the subcommittee will indulge in for a few minutes.

It also will have the advantage of keeping me from backing out later on anything that I may have said.

Although I am from Georgia Tech, I am neither an engineer nor an athlete. I speak for myself only, and as an economist, which is the only profession which I lay any claim to.

This brief statement which I have presented here, or will present is designed to explore the main avenues of the economic consequences of automation, and assist, I hope, this committee in asking the right questions to the expert witnesses who will follow; the witnesses who will be able to supply the necessary factual information.

Since World War II some spectacular discoveries in the fields of electronics and communications have permitted the manufacture of various types of automatic computing machinery. These machines are capable of translating a large body of previously developed, theoretical, economic, and business principles into practical significance. Called electronic computers, they are capable of processing data with almost unbelievable speed. When information is fed into them, usually on tapes, they can perform a series of logical operations and can choose among several previously anticipated courses of action based on built-in criteria. They can even adjust automatically for errors. The operation of these computers to solve scientific or commercial problems is often referred to as automation.

Also, in the last few years a number of automatic or semiautomatic machines have been constructed to supplement conventional assembly-line operations in factories. These machines perform hundreds of individual mechanical functions without direct human intervention. The operation of these machines is likewise commonly called automation.

Finally, scientists, computer manufacturers, and science fiction writers have shown, hypothetically at least, how the administrative and manufacturing processes of an enterprise could be integrated into a single, silent, automatic monster which could grind out an endless chain of products without a man in sight. This awesome picture has charged the imagination of some and struck terror in the hearts of others. The possibility of such developments is also called automation.

In addition to this definitional confusion many speculations, hypotheses, and fragments of theories concerning the broad economic and social implications of automation are currently being expounded. In this flood of verbiage there is no shortage of imagination, but there is a notable lack of the kind of critical thought and careful documentation which yields quantitative, scientifically accurate results. There is a great need to collect, sift, classify, and evaluate the empirical evidence which alone can test these generalizations.

It is not the purpose of this presentation to provide any conclusive, concrete facts or to try to verify any particular arguments by amassing evidence. Rather, the main purpose here is to try to establish a frame of reference within which the results of subsequent empirical investigations can be logically fitted so as to determine the probable impact of automation on employment and economic stability. Some facts will be used here to illustrate problems which require study but this statement will seek to achieve its main purpose by presenting (1) a definition of automation based on four basic principles which underlie all of the various popular concepts, (2) an estimation of the probable scope and speed of automation in the future, (3) a classification of eight major types of direct effects of automation, and (4) an evaluation of the impact of these effects on five principal tests of the performance of an economic system with particular emphasis on the maintenance of full employment and economic stability.

PRINCIPLES AND DEFINITION OF AUTOMATION

The variety of popular uses of the term "automation" necessitates some definition which is both precise and relevant for analysis. Such a definition can best be derived from an examination of the major principles which underlie most if not all of the popular concepts of automation. These are four such major principles—mechanization, feedback, continuous process, and rationalization.

Mechanization means the use of machines to perform work. Sometimes mechanization substitutes machinery for human or animal muscle. The steam engine did this. Sometimes mechanization substitutes machinery for brainwork at the lower, routine levels. The electronic computer does this. Because of the power, compactness or speed of machine operation, mechanization usually permits tasks to be performed which could never be done by human labor alone no matter how much labor was used or how well the enterprise was organized and managed. Mechanization increases wealth and reduces drudgery in the long run but in the short run it may cause hardships to workers whose skills are rendered obsolete, diluted by a further specialization or whose jobs are abolished altogether.

Feedback is the second principle inherent in automation. This is a concept of control whereby the input of machines is regulated by the machine's own output so that the output meets the conditions of a predetermined objective. As in a simple, thermostatically controlled heating system, the conditions created by the output automatically control, in turn, the amount of input and hence the performance of the machine. When controlled by the feedback principle, machines start and stop themselves and regulate quality and quantity of output automatically.

Continuous flow or process is the third principle of automation. This concept is of increasing importance because it is spreading from many individual production processes to the business enterprise itself and on to the entire economy. Mass production, increasing interdependence and now automation all embody this principle which is leading to a concept of the business enterprise as an endless process. Business for the most part has ceased being an operation that can be started and stopped with small loss. The regulation of a constant flow of goods has become a major concern of management.

This continuous-process idea has changed the function of management. The man of daring and imagination who relied on hunch supported by experience has become a technological casualty. The shrewd bargain has given way to the carefully calculated risk. The increasing size and complexity of business enterprises precludes the top executives from having knowledge of the details of the firms' operations.

Decisions must be made by groups who rely on reports from the sales, production, accounting and other departments. Top executives today are forced to view their functions as consisting of planning, controlling and coordinating the firm's operations and harmonizing the interests of the firm with those of employees, investors, suppliers, and customers. Because of the high degree of interdependence in the economy the decisions of these executives intimately affect the lives of millions of people.

Rationalization, the fourth principle of automation, means the application of reason to the solution of problems or to the search for knowledge.

In a production system it means that the entire process from the raw material to the final product is carefully analyzed so that every operation can be designed to contribute in the most efficient way to the achievement of clearly enunciated goals of the enterprise.

Actually, rationalistic philosophy is nothing new, having become an important force in the world with the Renaissance. However, the scientific, rationalist philosophy takes on numerous new implications when it can be implemented by modern electronic machinery. The rise of electronic computers has led to a fascination with the possibility that superrationalism in the business and scientific spheres might spill over and transform society into an exact mechanism in which all elements of chance, risk, capriciousness and free will, as well as all spiritual values, would be eliminated. Although this kind of speculation is highly dubious nevertheless it is one logical extension of this fourth principle of automation.

Following these four principles—mechanization, feedback, continuous process and rationalization—automation can be given a definition precise enough to be useful for logical analysis. It can be said to be any continuous and integrated operation of a rationalized production system which uses electronic or other equipment to regulate and coordinate the quality and quantity of production.

THE SCOPE AND SPEED OF AUTOMATION IN THE FUTURE

For the purpose of determining the extent to which automation can be applied to productive processes, industries can be divided into three groups. The first includes those industries in which production can be reduced to a continuous flow process. Oil refining, flour milling, and chemical production are illustrations of industries in which automation has made, and should continue to make, significant progress. In other industries, it is possible to revamp the productive mechanism in such a way as to convert it from a series of unit operations into a single endless process. While some industries utilize processes which are not conducive to automation, new methods of production may be conceived which are more acceptable.

A second class includes industries in which some automation is possible, but full or nearly complete automation is not likely. Indeed, it is possible that some industries may have automatic machines applied to 75 percent of their operations, yet the cost of making the plant completely automatic would more than offset the savings achieved from the use of partial application of automatic machines. In this category would be found industries which require substantial information-handling and accounting functions but in which the method of production or the nature of the product is not adaptable to continuous flow techniques. Such industries would include transportation, large-scale retailing, and the manufacture of certain nonstandardized consumer products like furniture.

The third group into which all industries may be classified includes those in which no significant application of automation seems likely because of the highly individualistic nature of the product, the need for personal services, the advantages of small-scale units or vast space requirements. These would include agriculture, mining, professional fields, and most construction and retailing.

Other limitations on the scope and speed of automation are more temporary but are nevertheless significant at the present time. These include (1) the high initial cost of the equipment which for the time being at least prevents all but the larger firms from using it, (2) the shortage of highly trained operators and analyzers, and (3) the time required to analyze the problems, reduce them to equations, program the computers and translate the answers into useful data. The solution to the problem of rethinking through the entire production process is likely to come slowly because of the tremendous mental inertia which is confronted in such cases.

DIRECT EFFECTS OF AUTOMATION

Following the principles and definition of automation already derived, the direct consequences of applying automation to a productive system can be classified as follows:

1. Many direct production jobs are abolished.
2. A smaller number of newer jobs requiring different, and mostly higher, skills are created. These new jobs include equipment maintenance and design, systems analysis, programing and engineering.
3. The requirements of some of the remaining jobs are raised. For example, the integration of several formerly separate processes and the enhanced value of the capital investment increase the need for comprehension and farsightedness on the part of management. Also, greatly decreased inventories and more rapid changeover times create tensions which require more alertness and stamina.
4. Production in aggregate and per man-hour is enormously increased.
5. The production of new and better goods of more standardized quality becomes possible. However, there may be a loss of variety. Many different models are possible from combining a few standardized processes in different ways but, as in automobiles, the final products are still likely to look pretty much all alike.
6. There is an increase in the quantity and accuracy of information and the speed with which it is obtained. Management can thus have a clearer picture of its overall operation and by knowing the consequences of alternative courses of action it can act more rationally.
7. In most cases a more efficient use is made of all of the components of production—labor, capital, natural resources, and management. In a few cases, high operating speeds waste materials, but even here the loss is usually justified by saving other resources including even time which is a valuable component of production.
8. A continuous pace is often set at which the plant must be operated.

IMPACT OF AUTOMATION ON THE ECONOMIC SYSTEM

In order to determine the economic impact of the above eight major effects of automation they should be evaluated in terms of the performance tests of a properly working economic system. The criteria of an economic system's performance, or the goals which an economic system should seek to maximize, can be classified as follows:

1. The level of employment of all resources.
2. The stability of employment of all resources.
3. The satisfaction of consumers' desires, that is a pattern of resource and product allocation which always satisfies the more urgent requirements first.
4. The efficiency of production, that is output divided by cost in human effort, physical resources, and lost opportunities.
5. Progressiveness, that is the rate of increase of productivity.

Of course, these goals cannot all be increased simultaneously. For example, maximizing, short-run aggregate living standards (No. 3) requires a more or less equal distribution of income if it is assumed—and it cannot be proved otherwise—that different people have the same basic needs and the same capacities for enjoyment.

Now equal income distribution, and hence maximum human satisfaction, is partially inconsistent with progressiveness (No. 5) because some inequalities of income are necessary to provide the incentive to increase productivity and hence long-run living standards. Consequently, some optimum combination of these five goals—particularly some compromise between short- and long-run living standards, should be sought.

The first goal, full employment, is now generally accepted as both an economic and a political necessity. The enormous costs of unemployment, particularly of labor, have been well documented. Human resources depreciate with time rather than use, and they depreciate it an accelerated rate when they are unemployed because of the decline of knowledge, skills, and morale. The main economic cost of unemployment is in production that is permanently lost.

However, the social costs of unemployment far exceed the economic costs, since unemployment also contributes in large measure to crime, disease, family disintegration, race and religious prejudice, suicide, and war.

It is on the employment of labor that automation has its greatest impact. A recent doctor of philosophy dissertation by David G. Osborn at the University of Chicago revealed that in 12 cases of automation ranging from chocolate refining to railroad traffic control the reduction in employee requirements ranged from 13 to 92 percent with an average reduction in employment of 63.4 percent. In the oil-refining industry employment has fallen from 147,000 to 137,000 in the last 7 years although output rose 22 percent. The Federal Reserve Index shows that production in mining and manufacturing was about the same at the end of 1954 as at the beginning, but total employment in these industries was down by almost a million. It is often said that such declines will be offset by increases in employment in the more dynamic sectors of the economy, but even in the electrical-machinery industry itself employment remained constant at about 1,100,000 from 1952 to 1954.

It is true that there have been no mass layoffs from automation, but this is apparently because automation has proceeded slowly enough so far to allow normal turnover to disguise the displacement. The worker displaced is not fired. He is the one who is not hired.

Another rather subtle form of displacement is in the so-called hidden unemployment of downgrading. It is true that automation creates a demand for new skills of a higher order and no doubt there will be a long run upgrading of the labor force. However, because automation renders many skills obsolete and dilutes other skills by a further division of labor, and since the new skills require extensive training and education, workers may not be able to move easily into the new jobs. When they cannot, they are often downgraded in work even though their pay is not reduced.

There is further evidence of this lack of upward labor mobility in the critical shortage of engineers and other highly trained specialists. The United States will graduate 27,000 engineers and 50,000 technicians in 1956 compared to 45,000 engineers and 1,600,000 technicians of comparable quality who will be graduated in the Soviet Union.

A recent National Science Foundation study shows that out of the upper 25 percent of high-school students about half are unable to go to college and another 13 percent drop out before finishing college. Thus, nearly two-thirds of those with the greatest potential for scientific leadership never receive a college education. Less than one-quarter of 1 percent of these ever continue their education through to the doctor of philosophy.

Industrial location is affected by automation and this, in turn, affects employment. There could be a shift in labor-oriented industries away from low-labor-cost regions for two reasons: First the smaller labor force reduces the savings from lower wages and, second, there is a smaller wage differential between skilled workers of different regions than between the unskilled and it is the more highly skilled workers who are likely to be retained if automation is introduced. For example, the new corn-products plant at Corpus Christi, Tex., was located in an area which normally would not supply a large skilled labor force. However since automation reduced the importance of a large labor supply this plant could be located closer to its markets and its sources of raw materials and fuel.

Since automation will be limited to industries which now employ only about 25 percent of the labor force, and because automation creates many new jobs for which the necessary education and training will delay the entry of young people into the labor force, there would appear to be no reason to fear long run, mass unemployment. However, there is no automatic regulator in the economic system that guarantees full employment and the advantages of automation can be insured only if there is a continued expansion. As automation advances in our basic industries the American economy becomes like a rocket which must continue to accelerate or else fall from the sky. This leads to the next criterion of successful economic performance the necessity for economic stability.

Here also the long-run outlook is good but the short run poses problems. In general, there is no more reason to expect a recurrence of the depression conditions of the 1930's than there is to expect another epidemic of smallpox. In both cases the causes are well known and the remedies are effective if they are applied. However, automation makes the need for vigilance all the more imperative because it has unstabilizing effects in the short run just like the original industrial revolution had. By greatly increasing the fixed cost of the plant, and setting a continuous pace at which it must be operated, the adverse consequences of shutdowns are magnified.

Unfortunately, the very increases in efficiency and technological progressiveness which automation brings are a potential threat to continued stability. The abundance of production itself which increases living standards also frees people from spending all of their income unless they so desire. Whenever basic necessities can be secured by most people with only a part of their incomes, full employment becomes precarious because prosperity is then sustained by that portion of total spending which is dependent on confidence rather than on physical needs. A prosperous economy is always potentially unstable in the sense that small changes in expectations can have magnified effects.

The costs of instability, however, are large for everybody. The businessman must maintain expensive inventories and hedge against price changes, if possible, or else take great risks of loss. The cost to the worker, however, is the greatest of all from a personal standpoint because he lives from day to day and thus he suffers first, and most acutely, when his income falls. It is clearly the responsibility of businessmen and the Government—since they are the basic economic decision makers of the country—to insure as high and stable a level of production and employment as possible.

The third criterion of economic performance—maximum satisfaction of consumers' desires—seems to be well met by automation. The great increase in output and improvement in quality of goods is bound to raise living standards if full employment is maintained. There are a few danger spots even here, however. A wealthy economy like the United States must continue to be reasonably equalitarian because its prosperity depends on mass purchasing power. If the benefits of automation are not shared with workers in the form of productivity wage increases and with consumers in the form of lower prices these mass markets will be threatened.

There is an additional need for maintaining a high level of consumption. This is because automation does not seem likely to create the great waves of primary and secondary investment that earlier technological developments did. The automobile, for example, stimulated vast investments in the oil, rubber, highway, and construction sectors of the economy. If the electronics industry does not call forth such secondary investment, consumption will need to rise to fill the gap. The 4th and 5th criteria of economic performance, efficiency and progressiveness, are both well met by automation. By its very nature automation increases productivity and accelerates technological progress. In the University of Chicago study referred to above, productivity increases in 12 cases of automation ranged from 14 percent to 1,320 percent in a case of office automation with the average for all cases being 382 percent. Space requirements alone were reduced from 12 percent for printed circuit fabrication to 94 percent for lard rendering with an average for all cases being 59 percent.

Whatever the short-run maladjustments and conflicts may be, automation favors the long-run improvement of economic well-being. America's high living standards are not due to any monopoly of knowledge, brainpower, or industriousness. They are due largely to the enormous amount of capital equipment which both sides of industry, management and labor, have with which to work. This capital increases efficiency and automation accelerates the process.

CONCLUSION

Although automation rides the wave of the future it is understandable why workers and consumers should be concerned. Our leaders of industry, who are men of vision, are also men of wealth and position who can afford to take the long-run view. But the rest of us live in the short run, unfortunately, and that is where the potential dangers lie. A high degree of public responsibility from the leaders of industry, labor, and government will be required if the mistakes of the first industrial revolution are to be avoided.

The Chairman. Thank you very much, Professor.

We will be greatly benefited by this statement of yours. We also have Mr. Diebold's book on automation which we are studying. I know we will be helped by both your statements and such other information as you gentlemen will kindly furnish to us.

Will it be agreeable to you, Professor, to engage not so much in a debate with Mr. Diebold, but in sort of a panel discussion? You can each one ask the other questions if you would like to do so, after I get through asking a very few questions.

I would like to ask about the relative importance, Mr. Diebold, of automation on, we will say, small business, and again on big business. Would it only help big business or would it help small business too?

Mr. Diebold. I think, Mr. Chairman, automation will very materially help small business. It will make possible through a number of factors, through leasing of capital equipment, which is a practice that is becoming quite common in the automation field, ability to lease decreases capital requirements for business and makes it possible for a smaller business to obtain automation equipment.

Through the introduction of flexible machine tools, it is possible for small shops to compete with some of the larger ones, to have the advantages of automatic operation without the large investments in capital equipment that the large companies undertake. It seems to me that automation is applicable in small industries, and makes for quite effective competition—mobility of small industries is such that there is a very real competitive power in them in competing with large companies. I think that automation provides an additional tool for this.

The Chairman. Professor Buckingham, I notice you stated near the middle of your statement that the high initial cost of the equipment, at least for the time being, prevents all but the larger firms from using it.

Mr. Buckingham. I think that is certainly one point of disagreement I would have with Mr. Diebold, although it would not be a basic disagreement. I think that for the time being certainly these computers and other equipment are very expensive. We have a computer center at Georgia Tech with two electronic computers. We are going to make these services available to small firms, but the cost is likely to range up to $20,000 a month, so this is likely to preclude the very smallest from using it. However, middle-size and large firms can begin to take advantage almost immediately.

I would like to disagree on one point with Mr. Diebold, and that is this: It is true that it is quite possible that automation will make possible the rise of small suppliers who can lease this electronic equipment and manufacture certain things for the larger firms. It is possible, but it isn't necessarily probable, so I think that there is a need for us to maintain constant vigilance in this area, to make sure that small firms and medium-sized firms get the same competitive advantages that large fully integrated firms receive.

There is a possibility, of course, that automation will—in fact, it is quite likely to—lead to decentralization of firms operations on a large scale. It is no longer necessary to locate your plant near the large population centers. The auto industry wouldn't have to be Detroit. It could be some place else. However, this doesn't necessarily mean that there is going to be a deconcentration of ownership. Decentralization and deconcentration of ownership are two entirely separate things.

The CHAIRMAN. Would you like to comment on that?

Mr. DIEBOLD. Yes, Mr. Chairman. A large part of our work, the work of my firm, is concerned with the introduction of automation to small businesses, and I think that it is perhaps too easy to assume that large capital investment is required in automation. Although you can rent computers for $20,000 a month, these are very large machines. You can also rent computers for $2,000 and $3,000 a month, and you can lease time on computers.

Small businesses can reduce their bookkeeping to a service bureau operation through the leasing of a few hours a month of time and you can measure that in hundreds of dollars. It can be too easy to point to the more conspicuous examples of automation in the large companies, and assume that is all you have.

I would like to point out what I thought was one contradiction in Professor Buckingham's statement. He initially said the level of capital investment required in automation was so large that only the giant companies could go into it. He later stated that it did not appear that automation was going to require a large capital investment, and that this would therefore not have the effect of secondary capital investment, and the stimulating influences that it brings to the economy. I wonder if he would comment on that.

Mr. BUCKINGHAM. I think there is a difference in the use of the term "investment" there. When a large corporation automizes—if that is a good term——

Mr. DIEBOLD. Automates.

Mr. BUCKINGHAM. Automates—it may invest in equipment or change its functions. At the same time, it is increasing investment in one area, it may be decreasing investment in another. The point I made, or try to make, was that the secondary influences are not likely to be as great as in earlier advances in technology. I think that the output of the electronics industry itself, although it has increased tremendously, is certainly not proportional to the output of other industries in the days when the railroads and the automobiles were first being introduced.

Mr. DIEBOLD. I think there are two contradictions there. I would like to get to the heart of this problem. One is that a general statement has been made—I think Dr. Buckingham commented on this—that the electronics industry does not typically have a large amount of capital investment and therefore the stimulation to the electronics industry that is brought about by automation is not one which will result in secondary investment, and consequently a high level of activity economically.

At the same time the statement is made that the electronics industry is not going to result in large-scale employment increases as it grows because it is using a high level of mechanization. I think these are contradictory areas.

The CHAIRMAN. High-salaried people will get higher salaries.

Mr. DIEBOLD. Also, the fact that they are introducing quite a bit of machinery in the manufacture of electronics is changing the economic characteristics of the electronics industry. The factor, for example, of printed circuitry, the idea of introducing printed circuits instead of having wires attached by solder in the back of a TV set. Instead of having this rat's nest of wiring which is very difficult, if not impossible, to assemble automatically, people have devised the concept of printed circuits, taking the pattern of circuitry and etching it on plates of vinylite, with conductive material acting in place of wires. This lends itself to automatic manufacture. It makes it possible to reduce such bottlenecks as those that have arisen during the Korean hostilities, for example, when mobilization requirements made it impossible to get the trained people to assemble electronic equipment.

This factor made it imperative that a heavy reliance was put on printed circuitry. This is being introduced into the TV manufacturing. You will see it in some TV sets. This general change is typical of what is happening in the electronics industry. Great increases in output are being made possible by reliance upon mechanization, upon very heavy increases in investment. Formerly you required only soldering irons and few parts. Now you begin to need substantial amounts of capital equipment. The changes that occur in the manufacture of components, also demand a heavy investment in capital equipment: this is changing the economics of the electronics industry. If you have an expansion of the electronics industry due to automation—which you are having—you do increase capital investment, as well as the general number of firms in the field.

A survey we did about a year ago indicated there were approximately a thousand companies in the country at the present time manufacturing control equipment. For some of these it represents their total output; for others it is only a small part; for example, GE, Westinghouse—control equipment is a small part of their total output. There are a thousand companies and a 3 to 3½ billion dollars a year output of this type of equipment. This is increasing at a very rapid pace.

The basic point I want to make is that I don't think you can use both arguments validly. I think one or the other is true. You either are going to have an increase in secondary investment, because you are increasing mechanization in electronics—you either concede that, and stick to your guns on the argument that you are not going to have as rapid an employment increase in the manufacture of such equipment—or you concede the fact that you are going to have an employment increase and not going to take a large capital investment.

The CHAIRMAN. Would you like to comment on his statement?

Mr. BUCKINGHAM. It is possible to have an increase in investment and decline in employment at the same time. This is one of the major problems because as we move into an area in which we must rely, not on a level, maintaining a continuous level of investment, but an increased level of investment, or rather an expansion of investment, then I think our stability becomes more precarious because we are relying for total spending on spending of businessmen, on capital expenditures, which can be stopped at any time. This is in contrast to the food and clothing purchases of individuals who will continue to purchase these things pretty much whether they have the income or not.

The CHAIRMAN. On the question of expenditures, aren't these ma chines leased generally rather than purchased outright?

Mr. BUCKINGHAM. I couldn't say.

Mr. DIEBOLD. I think it varies both ways, sir. In the office-equipment field you are predominantly concerned with the use of computers, leased equipment.

The CHAIRMAN. Do you mean almost exclusively?

Mr. DIEBOLD. No; I wouldn't say that. All manufacturers other than IBM in the office field will both sell and lease. IBM will only lease.

The CHAIRMAN. IBM will only lease?

Mr. DIEBOLD. Yes, sir. That is, the computers. They will sell some of their other equipment. All other manufacturing firms offer both opportunities, to buy it or to lease it, and in many cases, to lease with an option to buy.

The CHAIRMAN. I believe you gentlemen agree that, in order for our country to expand and progress, and stay on even keel of prosperity, we must have full employment and mass purchasing power.

I thought I gathered from both your statements that these two things are very important, full employment and mass purchasing power.

Mr. DIEBOLD. That is right.

The CHAIRMAN. If the purchasing power should turn downward, we would be in real trouble.

I notice your statement, Professor Buckingham, about education. I wanted you to elaborate on that a little bit more, if you will. You state—

> The United States will graduate 27,000 engineers and 50,000 technicians in 1956, compared to 45,000 engineers and 1,600,000 technicians of comparable quality who will be graduated in the Soviet Union.

Isn't that rather an alarming statement?

Mr. BUCKINGHAM. I think so. These figures came from a study from one of the national engineering societies, and their conclusion was that this was very alarming. Since there are long-run benefits to be gained from automation, and since automation is something that we certainly ought to encourage, there is a possibility that this shortage of highly trained specialists will become a bottleneck, which will limit the automation in the future. We are finding at Georgia Tech, for example, very great difficulty in finding the people with the necessary mathematical background, physics background, and even other trained technicians, to operate these machines.

The CHAIRMAN. So you think that is a real bottleneck right now, lack of education?

Mr. BUCKINGHAM. I think this could very well become a bottleneck very quickly.

The CHAIRMAN. Well, how will we meet this problem? What is your suggested remedy? How shall we proceed to get around that bottleneck?

Mr. BUCKINGHAM. Well, I think that since the immediate benefits of automation come to the business firm which is able to employ automation, that following my suggestion that both business and the Government should be prepared to accept responsibility for the consequences, I think business firms will find it in their own economic self-interest to increase the endowments of colleges, and universities, to make possible more scholarships, so that deserving, qualified, but impoverished students can go to college. These are students who otherwise would not be able to do so.

I think large corporations also may very well find it in their interest to set up training programs to train some of the workers who are displaced from jobs because of automation for the more highly specialized jobs which automation requires.

Of course, we must remember that all workers cannot be retrained. Many workers in their forties, fifties, and sixties who have worked at a single job for 20 or 30 years, cannot be sent back to college or through some training program and taught how to operate some computing machine.

These machines and automation in general require a high degree of stamina. The nervous tension is very high, and everyone is not well suited to this kind of work.

Mr. MOORE. I understood you to say, Mr. Diebold, that had we not had automatic processes, we might not have polyethylene in the quantities we had now.

Mr. DIEBOLD. Yes, sir. I used that as an example—I think it has been brought out by a number of people in the process industries that you could not otherwise produce certain products.

Mr. MOORE. Could you cite a few of the household implications of that? What would be missing from our day-to-day world today without polyethylene?

Mr. DIEBOLD. An increasing reliance, I think, is being put on polyethylene for use in everyday household items. This is, as I cited the case of it being used as containers for the drug industry, very rapidly increasing. A large amount of production output is being used in the chemical industry for containers and for bottling purposes, is being used for plastic sheeting, for industrial-tube manufacturing, even in the electronics industry itself as sheathing for wires and cables.

Mr. MOORE. It is essentially a whole new industry?

Mr. DIEBOLD. Yes, sir. I think atomic energy is another. You could not have an atomic-energy program without first fully automating the manufacture of radioactive materials.

Mr. MOORE. Professor Buckingham referred to a dissertation at the University of Chicago, which indicated a striking reduction in employment requirements in the 12 industries studied.

Is there a similar dissertation available which studies the cases of industries that have gone ahead and of whole new industries that have increased employment?

Mr. BUCKINGHAM. I am not familiar with any, but I think that we would find that there has been, of course, an increase in employment in many other sectors of the economy.

Mr. MOORE. In any case we have a pretty high level of employment today.

Mr. BUCKINGHAM. Yes. What is happening is a shift from direct production workers to indirect. This has been going on for a long time. At the present time many products are sold in which far more labor went into the selling, and the financing, and the advertising, and the packaging, and the design of the package, and so forth, than went into the actual direct production of the goods themselves, the physical production.

I think this trend is going to be accelerated. Automation puts more pressure here, which means we are likely to have an increased expansion in the various service trades.

Mr. DIEBOLD. I would like to comment, if I may, Mr. Chairman.

The CHAIRMAN. You may comment on that, Mr. Diebold.

Mr. DIEBOLD. I think that one of the basic factors of our economy is we are a dynamic economy; we have a high level of mobility and shift and constant change.

At the turn of the century the proportion of the labor force engaged in agriculture was very substantially higher than it is at the present time. The proportion of the labor force engaged in manufacturing has been decreasing during the past 20 years. We have had a shift into service industries. We are having comparable shifts within each of these industries. We have continual change in dynamic movement, from one industry to another.

It seems to me that the fact of automation is one which does not fundamentally change this. It may accelerate some of the change. It will bring about certain of the shifts. But it seems also me one of the points that we must look for in determining and assessing the economic effects, both short and long term, on labor and the economy, is to determine precisely what are the nature of the shifts? Where are we getting increases? How can we train people for these changes in requirements?

I think Professor Buckingham brought out some very good points. He emphasized the fact that businesses are forced by automation to be very concerned with assuring a continuous flow, a continuous output of their product.

This means their business has a very high stake in increased purchasing power and insuring that purchasing power. I think it would be very foolish and shortsighted to assume that businesses are not very concerned about this point, and are not well aware of the fact that they must maintain purchasing power.

I think Professor Buckingham also brought out a very important point in saying he felt that changes in automation will take time to be brought about; that it will be slow; that it is being held up by lack of trained manpower. And I certainly agree with everything he had to say about education, and the great importance of paying increased attention to the educational requirements of the country.

This I think is the key factor in determining the speed of automation: the availability of people to bring about these changes. And the speed of automation is in itself I think the key to the economic impact of automation.

It was, I think, the famous economist, Lord Keynes, who said, "In the long run we are all dead."

I think we are all concerned with the short-run changes of automation and what these will mean, businessmen no less than workers and members of the Government. The shifts that have taken place in the past, I think, were difficulties of the changing economy.

As for the figures in Dave Osborne's study at the University of Chicago, I would not consider them at all typical, or ones that could be applied "across the board." This was a very limited study.

I was directly connected with Mr. Osborne. He came to me for assistance in preparing his paper at the time, and I know that this was based on a small number of cases. It seems to me, concerning this figure of 63.4 percent average reduction in employment, that it would be very bad to give the impression that this is a general average expectation, as Mr. Moore has pointed out.

We have a very high level of employment at the present time, and we also have acceleration of automation.

Mr. **Buckingham**. I would like to comment, if I may.

One important social implication which has not been brought out is one I would like to underscore. It is a point made by Mr. Diebold in a paper he wrote recently.

It is that we may be faced in the future with the possibility of trying to find some way of making our society and our culture meet the needs of people who do not have to work their entire lives, in order to find a rewarding experience.

We will have to concentrate on what to do with leisure time. I think that a shorter workweek eventually will come. We have been seeing this going on in the past, and this raises a lot of social problems.

The entertainment industry is bound, I think, to expand as a result of this. We need to give considerable attention from the social point of view as to what kind of entertainment we are going to have. This is an industry that is going to absorb many of the workers who are displaced from direct production jobs, and the direction which this sort of thing could turn could be very important to us all.

The **Chairman**. Will you make a prediction as to what will happen to the workweek?

Mr. **Buckingham**. I think that certainly in industries that are likely to have automation applied to them there is going to be a pressure to reduce the workweek.

The **Chairman**. Do you have any figure in mind as to the hours per week in the future?

Mr. **Buckingham**. Some industries already, I think the rubberworkers, are on a 30-hour week. Of course by reduction of the workweek, this does not mean the reduction of the take-home pay. When the workers want a reduction of the workweek, they want less work for the same pay. I think there is an economic argument behind this; that is, again, if we are going to reduce the workweek, if we reduce the total take-home pay, that this will cause a fall in consumption, so this does not mean reducing the total take-home pay. It means maybe reducing the workweek from 40 to 36 hours, for the same total pay that is being paid for 40 hours now.

The **Chairman**. Do you have any comment to make on that, Mr. Diebold?

Mr. **Diebold**. I think I would certainly agree with Professor Buckingham's comments that it does not mean a decrease in purchasing power. If you are increasing the total output of goods of the economy, you may take part of that as material standard of living—as physical goods—and part as leisure. You can produce many more goods, and you either work the same number of hours and produce a great many more goods, or you cut down somewhat on the hours.

I don't know though whether we will ever be faced with cries for a 5-day weekend or not.

The CHAIRMAN. Would you venture a prediction on the workweek, say, when we have 200 million people in this country?

Mr. DIEBOLD. Well, too many people have gone down in forecasts. I think it is clear we are going to go down into the low thirties in terms of hours per week. It seems to me this is realistic.

The CHAIRMAN. What is your idea about that, Professor?

Mr. BUCKINGHAM. I would like to agree and add one other point.

Some studies were made, particularly in England during the war, and also in this country, that indicate that productivity in terms of output per man-hour can be affected by the number of hours worked per day, number of days worked per week, and so forth.

These British studies, for example, indicated that if workers worked 10 hours per day for 4 days and had a 3-day weekend, put in their 40 hours per week in 3 days, they would produce considerably more than they would if they spread the 40 hours over 6 days.

I think this explodes the old idea that if you have a 3-day weekend, workers will spend 2 days anticipating the weekend and 2 days recovering from it and you won't have any work at all.

Mr. MOORE. I have a question based on that point, Mr. Chairman.

Not all industries are susceptible to the advantages of automation. By what process and how long will it take for this short workweek to spread out into these less favored industries?

Mr. BUCKINGHAM. Perhaps it won't spread at all. Farmers work about as long as they ever did, I think. They are producing more because of the machinery, but I don't think there has been a considerable amount of reduction of the hours they put in.

Mr. MOORE. The other question I had is in connection with the problem of small and large business. I wonder, Mr. Diebold, if you could elaborate on a hint that you threw out; namely, that you foresee the early possibility of the introduction of tape-directed machines capable of handling small lots. Is that in the foreseeable future?

Mr. DIEBOLD. It certainly is in sight. I think that I made the point, or tried to make the point, that it is going to take some time before these are used widely, but perhaps I should explain a little about this idea. Traditionally we control machine tools by means of mechanical devices—cams and levers—and it is possible to achieve automatic production by building in a series of mechanical controls.

If you have a very long run of a product, if you know that you are going to make a product like this ashtray for a run of a million units, it will justify your efforts to tool up for it, to set up a process which will reduce the amount of time. You will have to set it up carefully and grind cams for it, but you will have an automatic operation.

There is a new concept introduced as part of automation into the way of controlling machines. Instead of storing information about a product in the form of cams or in the form of patterns to be followed, you can store the information on a magnetic tape or paper or vinylite tape and it is possible to build a machine (and a number have been built) controlled by such a tape. My firm has done a good deal of work in this particular area, and there are about 30 projects, I would say, at the present time in this country in which machines are being controlled by means of tape.

It is possible to put the instructions onto the tape, to play the tape into the machine control, and, through the use of servomechanisms and various types of other automation equipment, it is possible to control the movement of the tool and the actual movement of the machine.

If you have a run of 25 units, and this is typical of American production—the bulk of our national production is in groups of less than 25 similar items at any one time—you have these short runs and traditionally it hasn't been worthwhile to put in automatic machinery because you have to change it frequently and your investment would be enormous to do this. If you can use machines of this type, you can store the tapes. You can put it on a shelf.

If you make 10 of these units now and 10 later in the year you can store the tape. This has a number of implications. It has significance in such areas, for example, as aircraft manufacturing, if we were to try to put planes out at the same rate that we were forced to put them out during the Second World War, at the rate of one an hour in some of our large bomber plants. The changes in the technology of the planes themselves, the increases in the speeds, have meant a decrease, for example, in the thickness of the wing. It has become necessary now, instead of fabricating the wing, instead of putting it together by sheets of metal, to carve it out of solid blocks of metal. To do this by hand-controlled machines is an almost impossible task. It means that hundreds of hours of machining time have to be put into each part. In terms of the connecting unit between the wing and the fuselage of one of our planes—I think there are about 120 hours of machine time on that particular part, for each side of the plane—it would mean if you wanted to turn them out 1 an hour, you would have to have 240 machines of this type to do it.

This would be of that particular type of machine tool, about an 8-years' output of the industry. The military catastrophe that would result from reliance on such techniques is, I think, very plain. By means of tape controls it is possible to store this information in a tape, to use a machine that can operate much more rapidly, or cut metal at a higher rate than can a traditional machine tool and to quickly adapt a large enough group of general purpose machines into highly automatic special-purpose tools for quickly producing the necessary output.

It means you can vary the characteristics of the plane. You can change it from plane to plane, and the engineering changes in the aircraft industry are enormous. There are a great number of industries where ability to change is important.

I would like to comment on this point of Professor Buckingham's about standardization. I think, of course, we are having increased standardization. We are trying to get it in our parts, components, and we are relying upon the way in which these are assembled to provide some of the changes. However, the introduction of flexible machine tools is making possible the production of products of quite different types and characteristics. It isn't going to be all standardization.

We aren't all going to end up eating out of the same type of china, eating the same food, and driving exactly the same kind of automobiles. Perhaps automobiles are closer to this than other items in the economy. Consumers' preference is such that a manufacturer can't get away with standardization, completely. He is too suspectible to people coming in with other changes.

I think that although standardization is terribly important in bringing about automation, it would be giving the wrong impression to imply that everything is going to be the same.

The CHAIRMAN. Mr. Ensley, would you like to ask any questions?

Mr. ENSLEY. Mr. Diebold, you indicated the need for factual study of automation. Could you elaborate on the type of information and statistics needed for intelligent public and private policymaking?

Mr. DIEBOLD. I would like very much to, sir. I think there has been so much general talk about automation that really it is very hard to get down to the facts to determine precisely what is happening. This, as I said in the beginning, is one of the reasons that I think we all welcome these hearings, to begin to lay the basis for some facts.

It seems to me the way you have organized the hearings is extremely good. It is very good, the idea of case studies for specific industries. I think if this could be extended into long-term case studies, actually sending teams into industries, making case studies of specific occurrences and specific companies and then in terms of the structure of that particular industry, arriving at a projection of what realistically is going to happen in that industry in terms of technological change and the rate of that change, that you then can begin to make meaningful statements about the aggregate of the economy.

I think it is only by going back to the individual industries and individual plants within those industries that you can begin to get any real collection of facts about what will happen. You can't generalize about the economy. In certain specific industries, you will have very rapid change, in others very slow. Who should do such studies, I think, is an open question.

These studies can be divided into a number of components. Statistical agencies of the Government, I think, can play a very important role in this. It could be very useful, I think, if the BLS broke down and produced a series on the field of automation, in terms of the manufacture, and the output of equipment.

It is virtually impossible, or at least, a very big task. We tried a year ago to draw an index of what is really happening in the introduction of automatic equipment and automation equipment. It is difficult to bring this out. I think some of the individual areas could be brought out by BLS. That would be highly desirable. I think the area of skill requirements is something the Labor Department should be very much concerned with, specifically what changes in skill are required.

The productivity group, the people putting together the productivity series at BLS, are constantly concerned with change. There has been a high level of good case studies made by this group in the past.

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I think, too, it is the role of some of the private foundations. It seems to me this is an area that the Ford Foundation, for example, ought to be highly concerned with, because this is in its truest sense a field in which the changes are going to affect our entire society. That is the very reason for the existence of some of the groups such as the Ford and Carnegie Foundations. It seems to me perhaps some parts of these studies ought to be conducted by a group such as that.

The National Planning Association has been very active generally in this field. That is another group that is concerned with these changes. I am a member of the automation committee of the National Planning Association and we have expressed great concern about the study of these facts.

Mr. BUCKINGHAM. I wonder if I might underline this statement: I think what Mr. Diebold says is very important. I would like to go a step further if it is not already explicit in his thinking. Mr. Moore's questions and the statements made already imply there are far-reaching consequences of automation, but we are thinking of it in a framework that is somewhat obsolete. We are thinking in terms of market control of one type. This is control of particular industries.

We are thinking in terms of concepts which are somewhat out of date. It has been 16 years since the Temporary National Economic Committee made its monumental study, and since that time we have had World War II and 10 years of unprecedented prosperity which have changed many basic assumptions which need to be going on at the present time.

There is a great need of another study of the comprehensive scope of the former committee to investigate the business community in general, the economic system, and try to fit automation into it so we will not be using an obsolete framework of obsolete techniques. Since World War II, for example, large firms have grown much larger, but many of the predictions of the 1930's have not come true. Many of the predictions of increasing monopoly—we seem to have a lot of competition in areas where many of our theories would indicate we ought to have airtight monopolies.

We see practices coming to the fore which are not specifically touched by the antitrust laws which may have a great effect on lessening competition. Of course, the antitrust laws are based on earlier concepts. I think a temporary national economic committee with a view toward modifying our whole legal structure along this line would be something that would be most useful.

Mr. ENSLEY. I gather the two of you believe, first, there should be a regular gathering of data and analysis of these data by, say, the Departments of Labor, Commerce, existing agencies, and private groups, and, second, Professor Buckingham has some more monumental special study of our whole economic organization in mind?

Mr. BUCKINGHAM. I think a study of this type, a large congressional study, would serve to influence the private groups that Mr. Diebold is talking about, to orient their thinking, to get them interested in things, because this would concentrate attention in a central place, about a very important thing, and corporations and labor unions, and private research organizations, and State governments, and so forth, would become aware of these problems.

I think a lot of the research would be taken up from there by these other organizations.

Mr. DIEBOLD. I think these hearings, themselves, will play a large factor in that the hearings may very well stimulate some of the private groups undertaking research. I think the only modification I would like to make in your statement is that I do feel that the continuous gathering of data about automation is part of the general economic activity of the country and is certainly part of the data that should be gathered by Government organizations, such as BLS, that specifically have the mission of publishing information about the economic changes.

I think it would be unfortunate to tack too much on automation. I think there is a slight tendency to take this new term, and all of the marvelous machinery that goes with it, and to use it as a sort of umbrella for things that may very well be necessary, in any case.

I don't mean to say that another TNEC would not be a wholesome thing, but I don't think you want to present this from the standpoint of it being specifically automation. There are a great many other factors that are involved in this, and to tack it exclusively on to automation would, I think, simply be another factor lending to confusion.

Mr. BUCKINGHAM. I didn't intend to mean that would be the subject. I meant a general study of the scope of the TNEC, of which automation would be but one part.

Mr. ENSLEY. Whenever the committee takes up a subject such as this it is always looking for the economic-policy implications. A couple of points that you raised interest me. I gather substantial capital funds are needed to automate, and I gather both of you agree that we need constantly increasing mass purchasing power.

From your experience with business, Mr. Diebold, and from the standpoint of furthering automation, would you give priority to investment funds or consumer purchasing power if we have tax reduction?

Mr. DIEBOLD. I think there certainly is a considerable reappraisal constantly needed on the question of obsolescence, the rate of it and the extent to which you can depreciate, as far as equipment goes. Some of the depreciation statutes, I believe, are not entirely in keeping with the real terms of the requirements in a business. Obsolescence, of course, is far more important to a firm than the actual wearing out of the equipment and the rate of obsolescence has been increased substantially by automation. I think this has a direct bearing on taxation, as it applies to the allowance for depreciation. It seems to me that you want to be sure that you maintain your purchasing power, and you want to be sure that where it is possible you are enacting tax laws—and I think everyone is well aware of this; I don't think it is anything new—that you enact tax laws which insure that you maintain the large mass of purchasing power, and this is primarily from lower-income groups. This is, I think, a basic fact which everyone is well acquainted with.

The CHAIRMAN. Professor Buckingham.

Mr. BUCKINGHAM. I think there is a conflict inherent between having more consumption and having more investment. The question is whether we want higher living standards now, or whether we want higher living standards later. Now, this is a decision which is a political decision rather than a decision of economists. This ought to be made by people in elections, to decide which they want. The kind of studies which we were discussing, particularly Mr. Diebold's discussion of continuing to gather data in the various public agencies, would give the public the information which they need to know so they could decide whether they wanted higher living standards later or now. As a general rule, I think we certainly have to have a distribution of income which is sufficiently equalitarian that we maintain high level of employment. Once we have that and a high level of purchasing power, then I think the emphasis ought to be on more investment for the future.

As soon as we run into declining purchasing power, the emphasis might very well change toward increasing mass purchasing power, but it is a political decision rather than a decision that can be made by economists or engineers.

Mr. DIEBOLD. I think we come up against this basic conflict, as I pointed out before, this question of investment in a period of decreased employment. If you hit a slump, it seems to me that is the time when you want the investment. That is when you want to go into road-building programs, capital-equipment programs, because this will create a large number of jobs. I don't think it is something you want to relegate specifically to the boom time. It seems to me that fundamentally this comes back to the decision of the consumer.

I think Professor Buckingham is quite right in saying this is the decision of the people at large, not only in terms of elections. It is the day-to-day decision of the consumer: Do you want more goods now or investment and have them later? The investment programs certainly are a key factor in helping economic conditions of the country in a depressed period. I don't think it should be relegated to periods of boom at all. It just accentuates the problem of boom.

Mr. BUCKINGHAM. In periods of depression we need to accentuate both investment and consumption.

Mr. DIEBOLD. Certainly.

Mr. ENSLEY. You wouldn't make a judgment today, 1955, as to which would further automation fastest, tax adjustments which would stimulate investment, or tax adjustment, which would further stimulate mass purchasing power?

Mr. DIEBOLD. Both factors are important in making a decision in a plant. That is what it comes to, specifically; when you make a decision on the investment in a specific line of equipment. You are faced with both factors. I would say the key question that we face in such an analysis: What level of demand can you assume is going to be maintained?

If you can assume—you are certainly not likely—if you suspect you are going to have a big drop in demand, you are certainly not likely to make extensive investment in resources, no matter what the tax statutes are. This is a little bit like use of monetary restriction and encouraging factors in trying to get a revival in a slump. If you simply lower the interest rate, this in itself is not a big inducement to invest, unless you are sure you will have some purchasing power to buy it. In the boom period, the change in draining in a small portion of your tax laws are more severe. If you increase your interest rate this certainly affects the amount you are going to invest. The key reason you will invest is because you have consumers who will buy. I would say that is the key factor.

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Mr. BUCKINGHAM. I think there is one way of answering your question by putting it this way:

The level of investment or the amount of investment is much more volatile and dynamic. It has a much more immediate effect than changing the level of consumption has on total employment.

If we get into a severe crisis, a sharp downturn or upturn, then I think tax measures may well be necessary to stimulate or to affect investment, either to push it up or hold it down. However, about 80 or 85 percent of our total spending is consumption spending. The long-run basic problem is to maintain a high level of consumption so consumption cannot be affected as easily by changes in taxes as can investment.

I think although our long-run emphasis ought to be on maintaining a high level of consumption, that it is the investment factor which is the dynamic one. Our economy balances, so to speak, on a razor's edge. If it starts to fall one way, it is investment that can hold it up, not consumption.

But in the long run we need a high level of consumption.

I would like to comment on one other thing Mr. Diebold said.

It is true that actually these decisions have to be made by the whole people of the country. They cannot be made by experts, because these are really political decisions. There is a difference, however, between the political decisions of people in their elections and the economic decisions of people in their consumer purchases. There is an equal distribution of political influence as far as voting is concerned. Every person gets one vote. But in the market place it is the dollars that vote rather than people, and this is one thing which Government policy can very well affect. A person with a lot of money has many more votes in the market place than a person with a little money.

The CHAIRMAN. Would you like to comment?

Mr. DIEBOLD. Yes, sir.

I think his very last sentence emphasized again the first aspect, that it is purchasing power, I think, which is the key to the problem. Doesn't this basically come down between WPA and PWA, the philosophies of the two projects? You either try to stimulate economy by increasing investment or by increasing the purchasing power of citizens generally. I think it has certainly been borne out that the latter course is one which produces a more immediate and widerspread revival. I feel that it is a qestion of what people have in their pockets to spend that is the key.

The CHAIRMAN. I would like to ask you, Mr. Diebold: You are familiar of course with the Employment Act of 1946. Are you in accord with the objectives of that act?

Mr. DIEBOLD. I certainly am.

The CHAIRMAN. Are you?

Mr. BUCKINGHAM. Very definitely.

The CHAIRMAN. Do you think it has been worth something in the last 10 years?

Mr. BUCKINGHAM. I think it has not only been worth something, I think it has been a necessity.

The CHAIRMAN. Do you agree?

Mr. DIEBOLD. I believe it has been worth a good deal.

The CHAIRMAN. Any other questions?

(No response.)

The CHAIRMAN. Thank you, gentlemen, very much.

At 2 o'clock we will hear Mr. D. J. Davis, vice president, manufacturing, Ford Motor Co.

The subcommittee will stand in recess until 2 o'clock here in this same room.

(Whereupon, at 11:55 a. m., the committee recessed until 2 p. m., same day.)

AFTERNOON SESSION

The CHAIRMAN. The subcommittee will come to order.

When we asked Mr. Henry Ford II, president of the Ford Motor Co., to discuss with us the impact of automation on long-run levels of employment, he replied that you, Mr. Davis as the company vice president, manufacturing, could represent him, as one much better qualified to discuss this particular subject matter. I am sure that we must trust Mr. Ford's judgment in this matter and we are happy to have you with us this afternoon.

Your company has had a great background in this field. Many persons must have had some part in it and perhaps many more claim some part in it. Nevertheless, the impression I get from the wealth of materials available on automation is that Mr. D. S. Harder, now executive vice president of the Ford Motor Co., was perhaps the originator and early user of this word "automation" which, as people are fond to point out, does not appear in recent dictionaries although we can scarcely pick up a magazine without finding a reference to it.

While we are talking about the word, I think it would be well to remember, as Senator O'Mahoney recently reminded us, that—

> new problems are not created by new words. The problems appear first and the words afterward, but occasionally new words are invented to make old problems seem new.

While the word may be new, machine tools with more or less automatic devices, the assembly line, etc., have been with us for a long time. We are happy to have you, Mr. Davis. We look forward to hearing your testimony.

STATEMENT OF D. J. DAVIS, VICE PRESIDENT—MANUFACTURING, FORD MOTOR CO.

Mr. DAVIS. Thank you. I would like to read my statement first, if I may.

The CHAIRMAN. That will be perfectly all right. Proceed as you desire.

Mr. DAVIS. Ford Motor Co. welcomes the opportunity to appear before this subcommittee. I have been asked to speak for the company and to present our views on automation in the automotive manufacturing field and its possible effects on our economy.

We at Ford feel that a necessary prelude to any discussion of automation in the automotive industry is a brief review of the history of technological developments within Ford Motor Co. itself. As you may know, many regard the founder of our company as the father of mass production techniques in the manufacture of automobiles.

Without these techniques, there would never have been an automotive industry as we know it today.

Shortly before World War I, Mr. Ford set up an assembly line to produce flywheel magnetos. So far as we know, this was the first installation of progressive assembly on a moving conveyor in the industry. It reduced assembly time of the magnetos from 20 minutes to 5 minutes. This progressive assembly line principle then was applied to many other small parts, and the result was that assembly time of those parts was cut in half. These successes led to the big test of the new method. Assembly of automobile chassis in a street alongside the factory at Highland Park, Mich., was tried by pulling the chassis along a 250-foot route past stockpiles of parts spaced at regular intervals. This experiment reduced chassis assembly time from 14 hours to 6 hours. It was then decided to mount the wheels on the chassis and roll them down a channel track from one station to the next.

Introduction of a moving chain conveyor then eliminated the need for pushing the chassis. These successes resulted in the installation of conveyors throughout the Ford manufacturing plants to deliver parts to the main assembly line. This advanced assembly technique was a very important factor in enabling the company to produce the model T car in the large volumes and at the low prices which only a few years before would have been thought impossible.

Conveyors at Ford not only increased productivity by freeing operators from manual handling work, but also decreased overhead costs by reducing aisle and floor storage space. The net result of conveyorizing at Ford was a reduction, over a 5-year period, of 50 percent in the production costs of the model T. The reflection of that reduction in the selling price of the car greatly stimulated demand and opened the auto age.

Even in the very early days of the model T, the automotive industry had come a considerable way from the time when the first cars were built in back-alley shops and when no one took them very seriously. Those that were built in these little shops were so fabulously expensive that very few people could afford to buy them. Although there were only four cars registered in the city in 1895, Chicago banned them from the streets. Nevertheless, the idea of automotive transportation took hold and, in 1899, output reached 4,000. When, in 1904, production went up to 23,000, the Nation's leading financial experts warned the car makers that they were dangerously overexpanded and soon would go bankrupt.

To us that sounds silly now. As a matter of fact, the bankers probably were right, or they would have been but for one thing. The American automobile manufacturers were to realize the advantages of mass production techniques as established at Ford, and as the cost and prices of the cars went down, the industry grew and America was put on wheels.

From its humble beginnings, it is now a matter of cold statistics that the automobile has been responsible for 90 percent of the employment in the gasoline industry; 80 percent in the rubber industry; 70 percent in the plate-glass industry; 60 percent in alloy steel—along with substantial percentages in a great many other industries.

Manufacture of the model T, of course, was a relatively simple matter, when compared with the production of our modern car lines today. The model T had less than half the number of parts that go into our current cars—5,000 as against more than 10,000; they came in any color the customer desired, so long as it was black; there were only a few basic body styles, and those did not change radically from year to year.

In recent years the rapid rate of change in our products has dictated major changes in our productive processes. Our manufacturing facilities now must be sufficiently flexible to permit mass production of hundreds of different models, styles, and colors, and these change radically from year to year.

We at Ford have expanded our manufacturing facilities tremendously since the war, and we are continuing to do so. Since 1946 the company has invested almost $2 billion in new facilities and plant expansion, and we plan to spend many millions more in the near future. At the beginning of this expansion program, a new department, which we called our automation department, was organized to coordinate the planning and inprocess handling activities of the stamping operations. This department then branched out and reviewed the inprocess handling problems of other areas, such as engines and engine components.

These early programs at Ford, however, were concerned chiefly with the rearrangement of standard and existing machines and the tying of them together with mechanical devices in order to eliminate many of the hazardous and costly manual handling operations. A gradual evolution then began, and at present there are many groups in the various divisions of the company working on their respective automation programs.

All of Ford's new plant layouts in recent years have been based upon the use of inline or transfer machines and mechanical handling devices between them whenever our studies have shown that their use is justified. In planning and executing this program we feel that we are doing no more than our predecessors did when they utilized new technology to mass produce the model T. We do not believe that automation, as we use it, is a revolutionary development in production technique; rather it is just another evolutionary phase of our advancing production technology.

To emphasize that automation, as we consider it, is not new, consider the well-publicized flour mill that was conceived and built back in 1807, almost 150 years ago. In this flour mill the grain was dumped into a hopper that led to a scale, where it was weighed and dumped again into another hopper that had a screw-type conveyor at the bottom. This conveyor carried the grain to a bucket elevator, which raised it to the top floor. From the top floor it flowed by gravity to another screw conveyor that carried it to hoppers feeding the mill stones. As the flour emerged it was fed mechanically to screens, then into barrels, and finally carried away by wagon or barge. This was true automation, whether the designer of that mill knew it or not.

At Ford we have defined automation as "the automatic handling of parts between progressive production processes." It is the result of nothing more than better planning, improved tooling, and the application of more efficient manufacturing methods which take full advantage of the progress made by the machine-tool and equipment industries.

As used at Ford, automation covers a wide variety of material-handling and related devices. In the machining of engine cylinder blocks, for example, automation moves the parts being manufactured into and out of load and unload stations automatically and, at the same time, actuates the machine cycle through electrical interlocking. When it can be applied, automation also is used to index the part, position it, turn it, or rotate it, depending upon the requirements of the succeeding operations.

In most cases a finished unit of Ford automation equipment for such machining operations is made up of a combination of standard elements, such as conveyors and simple air, hydraulic, and electric control mechanisms to generate the desired movement necessary for the in-process handling.

The electrical interlocking to which I have referred is a signal system, usually accomplished by means of limit switches and relays actuated by the movement or position of the part in the process. The actuation of these limit switches indicates to the automation control panel that parts are in position to be moved by the mechanism, and that all transferring equipment within the machines and equipment are in positions that will not interfere with the movement of the part.

To accomplish this, it is necessary that an electrical interlock be established to indicate that the machine or equipment is, as we say, "in the clear"; and also, that it will maintain this condition even though there may be some delay in the completion of the automation cycle. For most machinery and equipment, an interlock is required both at the loading and unloading stations. The loading station interlock must indicate that the space is open and that the transfer bar location will permit the loading of the open station.

When the open space has been filled by the automation unit, the interlock must then indicate that the part is in the proper location and that the automatic transfer mechanism is also in the clear. So long as the machine tool is operating on its automation cycle, it will then permit the next machine cycle to start.

An automated press line is another typical example of the use of automation equipment.

Sheet-metal blanks are first positioned at the front of a draw press, where a man loads them into the press loader. The press loader is a mechanical device that loads the blank between the dies and, at the same time, actuates the press cycle. When the press has completed its cycle and the dies open, a lifting mechanism built into the die raises the formed part so that it can be extracted by a horizontal extracting device, or iron hand, as it is commonly called.

The extractor deposits the formed part upon a mechanical device which positions it for trimming in the next press, and at the same time deposits it on an indexing device that conveys the part into the trim die. After trimming, the part is lifted in the die in the same manner as in the draw press and is extracted once again with a horizontal extractor, or iron hand. These mechanical handling operations are performed at each of as many presses in the line as are dictated by the process. Upon completion of the last press operation, the formed parts are stacked or conveyed to storage or assembly areas.

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In our press lines, automation has reduced, but not eliminated, the need for press attendants. One outstanding feature of our new press lines, however, is that attendants are no longer required to have their arms or hands in the hazardous areas of the press operations. Nor do they drain their energy through continuous tugging and hauling on heavy, awkward sheets of metal with raw or sharp edges.

The economics of this kind of technological advance are clear. Back in 1908, for example, it took a skilled sheet-metal man, working with handtools, approximately 8 hours to shape the upper half of a fuel tank. Today, in our modern stamping operations, it takes approximately 20 seconds. If handtools were still used to make the upper half of a fuel tank, the labor cost would be approximately $15. Its actual labor cost today is only a few cents. On that same basis, an $1,800 car today would cost approximately $15,000.

In today's competitive market we use automation or improved processes, wherever they are justified, in order to reduce costs or improve our product. If we did not use them, we would soon find ourselves at a competitive disadvantage.

Automation, however, cannot be engineered into every job indiscriminately, since it is not always feasible or profitable. Each application of automation must be carefully analyzed before it can be justified. If either daily volume of the part is low or long-term use of the machine is limited, any possible direct labor savings through automation are reduced and may be offset by increased maintenance costs and depreciation or obsolescence. For example, we can economically justify the application of automation to the manufacture of engine components for the Ford engine. The same extensive application of automation, however, cannot be justified on the tractor and Lincoln engine components, due to their lower volume requirements.

As we now see it, there also is little prospect for extensive application of automation in our car-assembly operations, where we assemble in 20 different locations and are faced with technical problems and early changes in product design. Any automation that is applied there must be readily adapted to these changing conditions and alterations at a reasonable cost.

In planning for automation, we must be sure that new machines and equipment will produce acceptable parts without excessive down time and maintenance work. In a standard or nonautomated production line, operators constantly tend and can adjust each machine. If one machine breaks down, a backlog of materials for the machine can be built up while the repairs are being made, to be worked on later on an accelerated schedule.

If one machine in an automated line breaks down, however, all production on that line is halted until the necessary repairs are made. Once the unit is repaired, recovery of lost production must be accomplished on overtime or extra hours.

Although automated machinery and equipment may appear to be technically feasible with respect to a particular part, Ford cannot install them unless they can be adapted, modified, or realined without excessive cost to accommodate the expected changes in the part. Planning for this flexibility requires expenditures of considerable time and money, and when compared with the savings obtainable from automation, we may decide to continue using nonautomated equipment, or to use a reduced amount of automated equipment on these jobs.

If we determine that automated equipment should produce savings in operational costs and that its probable life will permit full depreciation, we must still determine whether its original cost is justified.

Automated machinery and equipment, because of its complexity, often cost more (including engineering planning) than nonautomated machines and, in any event, is a new investment. Therefore, increased depreciation charges may nullify savings otherwise obtainable and make the risk of installing new automated production line too great.

On the other hand, particularly where new facilities are necessary, automated equipment may cost less than old-style machines because of savings in materials from combining several operations in one machine, and indirectly, where plant expansion is involved, because of reductions in floor space, lighting, and heating requirements.

In some of Ford's new plants, for example, the use of automated equipment required 40 percent less floor space than nonautomated machinery and equipment producing the same products in the same quantity.

Thus, automation, although technically possible for many processes, is feasible for only a portion of them, and requires thorough study before it is applied to any process. Where automation can be economically applied, however, the benefits may be fivefold: increased production, lower accident rate, lower direct labor costs, improved quality in the product, and reduced floor-space requirements.

EFFECTS OF AUTOMATION AT FORD

We have been asked, from time to time, what effect automation has had on our labor force. We believe that instead of adversely affecting employment at our company, automation has created better jobs, while at the same time making them safer and easier.

Our Cleveland engine plant, which has been referred to erroneously as an automatic plant by some of the more enthusiastic press and trade magazine writers, actually is a far cry from a fully automatic plant. What we do have at Cleveland, however, and more recently at our Dearborn engine plant, is a marked improvement over our past manufacturing methods. Where once we had 2, 4, or 6 separate manually operated machine tools, we now employ a single, multipurpose, machine tool. Where in the past we used chain hoists and conveyors, requiring considerable manual handling of heavy, rough pieces, such parts are now moved automatically from machine to machine and are mechanically loaded, positioned, and unloaded from the machines.

This has resulted in more complete utilization of the machine cycles, which tends to offset the increased investment, and has eliminated many heavy, dangerous, manual, handling operations.

Now, let us look at what has happened to employment in our engine machining and assembly operations. In 1950, Ford and Mercury engines were built and assembled at our casting-machine plant and motor plant in the Rouge, and the Lincoln engine was built in our Lincoln-Detroit, plant.

In 1954, the Ford 6 and the Mercury engines were built at our Cleveland plant, and the Ford 8 and Lincoln engines were built at the Dearborn engine plant. Engine production for these years was practically the same, 1,933,661 units in 1950 and 1,954,049 units in 1954, an increase of 1 percent. During the year 1950, a monthly average of 8,253 direct labor employees worked on engine production, compared to a monthly average of 6,399 such employees in 1954.

What happened to the people apparently displaced by automation? Although there were 1,854 less direct labor personnel employed in 1954 than in 1950, on engine production, these people were absorbed in our other operations.

In addition, in 1954 there were 976 more skilled maintenance personnel employed on engine manufacture than in 1950. As of September 15, 1955, there were no seniority employees on a laid-off status from either of the two plants.

With respect to the future of automation at Ford, we now can foresee only a limited application in our assembly plants, which currently employ about 30 percent of our total work force. For instance, in our three new assembly plants which started production this year, the principal differences in these plants from our older assembly plants lies in more adequate floor space, which provides for a smoother and more efficient flow of materials, rather than in any distinct changes in our assembly methods.

In addition to the inherent nature of automotive assembly-plant operations which militates against automation, technical barriers, plus the competitive demand for continual changes in body structure and trim design currently prevent the extensive introduction of automation in assembly plants.

We have found that, where applicable, automation has supplanted heavy, dangerous, and unpleasant work with easier, more pleasant, and more interesting work.

Moreover, the number of skilled higher-paying jobs has increased substantially, in both relative and absolute terms. Finally, and this is of prime importance, these jobs became safer for our employees.

Our records for 1954 show that on the cylinder block machining operations, which were most significantly affected by automation, the frequency of accidents decreased 60 percent from 1950.

In addition, automation inevitably brings vast new work opportunities to those who are willing to work and learn.

Very frankly, we cannot trace in precise detail the extent to which and manner in which automation and other measures to improve efficiency have affected our overall employment figures. Employment volume is affected by a large number of factors, including, among others, product improvements, changes in product mix, and a myriad of make-or-buy decisions on components.

The fact is, however, that Ford Motor Co.'s nondefense employment has increased, not decreased. During 1954, total man-hours worked were 14 percent greater than in 1950, an increase greater than the increase in our unit production. Our nondefense employment continues to be higher than in 1950.

We do know that without the improved efficiency and cost performance to which automation has made an important contribution, the continuing improvements that we have made in the quality and value of our products would not have been possible within the limits of a competitive price structure.

Consequently, we would not then be in the strong competitive position which enables us to sell enough Ford products to sustain our current expanded employment—and all this despite substantial increases during this period in the amount we pay our employees, both directly and in fringe benefits for an hour's labor.

CONCLUSION

Looking at automation from the broader viewpoint, all of us recognize that our supremacy as a world power today is due not alone to our natural resources; it is due in major part to our technological progress.

This progress, which has been made possible only through a free enterprise system spurred by vigorous competition, has produced for us a standard of living envied by the entire world.

Automation is just another normal step in our continuous technological progress. Certainly, such progress will create changes. But progress in itself is change—a change always for the better.

We can expect with confidence that automation will bring to our economy the same blessings that all other increases in productivity have brought to us down through the years. In the forward march of technological advances, whole new industries have been and are being created, which provide new job markets for all industrial workers.

Automation is but one of the children of a vast family of technological developments now emerging in plastics, electronics, atomic energy, and so forth. All of these developments open unlimited fields for the diversification of industry and for the introduction of many new products that do not now exist, just as television did not exist commercially 10 short years ago.

We at Ford do not share the apprehensions of some that the increased use of automation equipment may throw thousands of people out of work or otherwise dislocate our economy. Indeed, without automation in the steel, chemical, refining, food processing and cigarette industries, to mention only a few that are much more highly automated than we ever hope to be, there simply would not be enough production of their products to fill our needs, and certainly not at prices we could afford to pay.

Since, in our opinion, the growth of automation will be an evolutionary and not a revolutionary process, it should cause no more than a gradual shift of employment, a shift comparable to that from backward industries into new and growing industries.

This type of shift has characterized our dynamic economy for many years, and is one to which the American people are long accustomed.

The most significant feature of any shift in employment that may result from automation is that much of the shift will be from menial labor to higher skilled, better paid, safer, and more interesting jobs.

We believe that automation can and will become an important addition to the strength of our Nation and to the free world. The growth of our influence in the world has always been directly related to our advances in industrial productivity. We now have only 6 percent of the world's population, yet we turn one-third of the world's total production of goods and services, and almost one-half of its durable goods. This is because our national genius has found its clearest expression in industrial and scientific technology. We owe it to ourselves and to our country to take full advantage of the skills we possess and to apply any and all technological advances as they become available to us.

The CHAIRMAN. Thank you, Mr. Davis, for a very interesting statement. I personally appreciate it very much. I know the other members of the committee will be glad to read it. I wonder if you would like to identify for the record the gentlemen you have with you.

Mr. DAVIS. Yes. I have Mr. L. T. Williams, of the general counsel's office, Clerance C. Donovan, of industrial relations, and R. B. Darragh, general counsel's office.

The CHAIRMAN. Now, in order to continue to produce as many automobiles, trucks, and tractors, and everything that you produce, as you have in the past, it is going to depend on the power or the ability of the people to consume and buy them.

Mr. DAVIS. Yes, sir.

The CHAIRMAN. What do you estimate the automobile production for the year 1955 will be, Mr. Davis, in passenger cars?

Mr. DAVIS. We think it will total 8 million.

The CHAIRMAN. What do you estimate will be the production for 1956?

Mr. DAVIS. We think it will be generally about the same, sir.

The CHAIRMAN. About the same.

What about 1957?

Mr. DAVIS. We think perhaps a little more. We think perhaps almost 9 million vehicles.

The CHAIRMAN. About 9 million vehicles then?

Mr. DAVIS. Yes, sir.

The CHAIRMAN. In order to sell those vehicles, Mr. Davis, will it be necessary for installment purchasing to continue as it has in the past and not be restricted?

Mr. DAVIS. I would think it would be, sir.

The CHAIRMAN. You think that anything that would prevent or seriously hinder installment purchasing of automobiles would make it more difficult if not impossible for you to market the number of vehicles you contemplate producing?

Mr. DAVIS. I would think that would be right, sir.

The CHAIRMAN. You don't see any danger in the present amount of installment purchasing?

Mr. DAVIS. I would have no opinion on that.

The CHAIRMAN. You wouldn't have any opinion on it?

I wonder if either one of the gentlemen accompanying you would like to express a view on it?

Mr. DONOVAN. I don't think so.

The CHAIRMAN. Do you see any danger in the trend toward higher cost of money, or higher interest rates in installment buying that would possibly deter installment purchasing?

Mr. DAVIS. No, sir, I don't.

The CHAIRMAN. You don't see anything in that yet?

Mr. DAVIS. No, sir.

The CHAIRMAN. You do realize that the interest rates have consistently gone up?

Mr. DAVIS. Yes, sir.

The CHAIRMAN. And that of course is reflected in higher rates to the people who buy their automobiles.

Mr. DAVIS. That is right.

The CHAIRMAN. But you don't think it has reached the point yet to where you would consider it a danger or deterrent?

Mr. DAVIS. No, sir, I do not.

The CHAIRMAN. Now, tractors of course are sold almost exclusively to the farmers, aren't they? I mean, the larger portion of them?

Mr. DAVIS. Yes, sir. Our tractor business has shifted in the last few years. Formerly we made a great many tractors that were used in shop service, but with the expansion of the tractor market, our tractors are perhaps 90 percent used for farm work at the present time.

The CHAIRMAN. Do you see anything in the future that indicates to you that the farmers will get tractors cheaper than they are getting them now?

Mr. DAVIS. No, sir, I do not.

The CHAIRMAN. What is the solution of the farmer's problem then, Mr. Davis? They can't continue to pay more and more for everything they buy and receive less and less for everything they sell and still continue to buy tractors.

Mr. DAVIS. Well, of course, Congressman, our tractors are priced, based on our costs. Costs are continually going up, as you well know.

The CHAIRMAN. Are you alarmed about the farm situation as it might possibly affect our entire economy, including the automobile and tractor production business?

Mr. DAVIS. I am in no position to offer an opinion on that, sir. I do not know. All I do know is this, that the sale of farm implements in the last 2 years has been somewhat less than it had been prior to that.

The CHAIRMAN. With your company, or with all companies?

Mr. DAVIS. With all companies.

The CHAIRMAN. Do you have a figure in mind that would indicate the percentage?

Mr. DAVIS. No. I have no direct figure in mind.

The CHAIRMAN. Would it be 10 percent less the last few years?

Mr. DAVIS. I think it would be slightly more than that. My information on it comes from reading the Journal and other papers, of course.

The CHAIRMAN. Was it more in 1953 than in 1954?

Mr. DAVIS. There were more sales in 1953, I believe.

The CHAIRMAN. More reduction. Was the reduction in 1954 greater than in 1953?

Mr. DAVIS. I wouldn't know from the broad coverage. I would know what happened in our particular company. We changed models at that time and we had a very good year, generally speaking.

The CHAIRMAN. Has the consumption been off in 1955, likewise?

Mr. DAVIS. It has been down.

The CHAIRMAN. You attribute that, of course, to the reduced buying power of the farmer?

Mr. DAVIS. I would think so.

The CHAIRMAN. I know how popular your automobile is, because in 1928 I was permitted to get the first Ford, model A, to come to the

Southwest. I used it to good political advantage. More people came to see that Ford than came to see me. That way I got a good crowd everyhere I went. I am indebted to Ford.

Mr. Davis. Yes, sir.

The Chairman. You know it had been out of production quite a long time, about 18 months and people were waiting everywhere waiting to see the model A.

Mr. Davis. At that time I wasn't too interested in Ford. At that time I was a General Motors employee.

The Chairman. Would you like to ask any questions, Dr. Moore?

Mr. Moore. Mr. Davis, you have referred to $2 billion of capital expenditures since the war, and made a later reference to an "automation department," which was organized in your company to advance the cause of automation.

I wonder if you could estimate how much of that $2 billion went for normal replacement. More explicitly how much of this sum would you say originated or grew out of the activities and engineering of this special automation project?

Mr. Davis. I would say automation such as we started in 1952 when our engine programs went into full swing in new plants at Cleveland, at that time automation cost approximately 25 percent more than if you bought the normal machine tools.

Since then we have standardized a good many elements used in automation and the cost is somewhat less, but as I said in my statement, there are very few parts that you can really do a bangup job of automating on. I might tell you this: That in our Cleveland and Dearborn engine plants we have automated lines on cylinder blocks, cylinder heads, connecting rods, chankshafts, and camshafts. That is all for the engine. Totally, in the company, perhaps only 6 percent of our employees, direct labor employees, work on automated lines.

Mr. Moore. What percent?

Mr. Davis. 6 percent.

Mr. Moore. How many employees does the company have?

Mr. Davis. About 146,000 hourly employees.

Mr. Moore. So you mean there would be some 10,000 of those?

Mr. Davis. That's right. Mr. Donovan advises me that would be on the high side.

Mr. Moore. You have referred to the combination of standard elements into transfer and automatic machines.

I suppose as a converse to that you would say 75 percent on one of these automated lines are standard milling machines that might once have been operated by a human operator.

Mr. Davis. That is not quite right, sir. I say that the automation costs an additional 25 percent.

It is true that these in-line or transfer machines in themselves are automated between stations, and the automation I speak of is that which goes in between these machines.

For example, a cylinder-block line consists of 71 machines hooked together automatically. That single machine, as you look at it now, is perhaps 1,600 feet long, but it has 71 pieces of automation in between these machines. To move the part automatically between the various in-line operations, it is that long.

Mr. Moore. Of the total capital cost of that machine, you would say 25 percent was sunk in automation.

Mr. Davis. I would like to clarify it for you by saying this, that a cylinder-block line producing 140 units an hour at 80 percent efficiency—bear in mind, when I say "80 percent efficiency," it is only possible to operate at 80-percent efficiency through use of automation. If you had no automation, you would be lucky to get 65 percent efficiency in that line, but the pieces of equipment that lay in between these pieces of end-line machinery are the 25 percent in extra dollars that I speak of.

I say that a cylinder-block line not automated would cost $7 million. Our first attempt at automation cost us 25 percent more than that.

Mr. Moore. When you automate a line or reach the decision to do so, is it practical to convert an existing plant or do you move from, say, Dearborn to Cleveland and then again from Cleveland to Dearborn the next time?

Do you allow an old plant to sort of wither on the vine and abandon it and go out and start fresh building a new automated plant?

Mr. Davis. That is what we would like to do. We are not always able to do that because of the expenditures.

You recall, the first line I said we automated was at Cleveland. When we put that automation in at Cleveland, there was nobody in the business that was selling any equipment in that line. We had to go out from—start from scratch and do a good deal of the designing ourselves.

Mr. Moore. Had you been making engines in Cleveland at that time?

Mr. Davis. No. We had to interest people on the outside to go into building of automation equipment, people like the Wilson Co., of Detroit. We learned after we made that installation that we had very little flexibility, so we set a group to work trying to standardize on these automation units.

We now have standard 3-foot units, 6-foot units, 9-foot units, that would either turn the work over, rotate it, or do something to position the part.

As a result of that standardization program we have much more flexibility and we can take, for example, a piece of equipment off the cylinder-block line and use it on the cylinder-head line.

The Chairman. Mr. Ensley, would you like to ask some questions?

Mr. Ensley. Mr. Davis, moving from one location to another in the interest of increased efficiency involves, of course, a lot of labor adjustments.

Mr. Davis. Yes.

Mr. Ensley. How do you approach those problems, the finding of new positions for people that were closed out of former operation, particularly if the new operation which you are undertaking is located in a different geographic region?

Mr. Davis. Well, sir, we were in a very fortunate position because our company has been expanding since 1949, and we have been building a great many new plants.

In Cleveland, where we operate four plants at the present time, we had no such problem, because we had no employees in Cleveland. We moved people from Rouge to start Cleveland.

At the Rouge, when we went into the overhead-valve engine job, we also had a motor plant at that Rouge that employed a great many more people, making the old L-head motor, than we could use on the new overhead-valve engine. But to supplement that we put the Lincoln engine in with it and we used those people.

Mr. ENSLEY. And it would be your judgment that in future shifts of that type, the employees would be able to adjust, as long as we have an expanding economy?

Mr. DAVIS. I am sure that is right, sir.

One interesting sidelight might be this:

People that moved over to the new Dearborn engine plant from the old Rouge engine plant, as we call it, some of them did not want to go on automative lines to begin with, but after they were there a day, you couldn't get them back in their old jobs.

Mr. ENSLEY. Would it conceivably involve downgrading if they moved from one job to a new job?

Mr. DAVIS. We think it would definitely be upgrading because at the present time we have many schools, and we are running classes to take our normal labor and upgrade it, either make them job centers or maintenance people on the higher type jobs.

Mr. ENSLEY. Do you find the retraining program that your company engages in is working successfully?

Mr. DAVIS. That's right, sir.

Mr. ENSLEY. And the people involved, irrespective of their age, are able to adapt themselves to new processes?

Mr. DAVIS. That is right, sir.

I think Mr. Donovan might like to say a word in that respect.

Coming down on the plane this morning he made a remark to me about our seniority employees, and what the approximate ages of some of these people are.

Mr. DONOVAN. The average length of service of our operators on the cylinder-block line and in the new Berwin engine plant is 25 years. Those people have been trained in the old processes and then retrained to the new processes, and we found that we were able to accomplish it with very little difficulty.

Mr. ENSLEY. In connection with training and education, on page 15, you say:

> This is because our national genius has found its clearest expression in industrial and scientific technology.

From your standpoint, as a user of technicians, scientists, mathematicians, and so forth, are we keeping up in the field of education? Some say we are retrogressing.

Mr. DAVIS. I don't think that is at all right. For example, the chairman of our board was down at Oak Ridge a few weeks ago, Mr. Breech, and we had lunch one day together and he said to me, "I saw some wonderful goings-on at Oak Ridge in the use of isotopes. I would like to send you down there and let you see what they are doing with isotopes in the field of gaging."

I said, "You don't have to send me down there. We have them here."

And I put an exhibit together for him, and certainly we have many uses for isotopes in our company that we are presently using and will have many more.

I think it is one of the grandchildren of automation.

As we go along in this thing, the job you tool today, if you can't do it better tomorrow, you are doing a pretty poor job. We look for

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good people. If we had people that did a poor planning job, they wouldn't last on their job, because we have to be competitive.

Mr. ENSLEY. Do you find that the pool to draw upon is drying up?

Mr. DAVIS. Not at all. We have had no problem in that respect. However, we have done a lot of encouraging with various universities, and we do have a program with universities, bringing people in each year on special courses.

Mr. ENSLEY. One of the second needs from the education standpoint we were told this morning was for the worker to be better educated so that he could more satisfactorily make use of the growing leisure time that he will get as a result of technological development.

Do your employees make good use of their leisure time?

Mr. DAVIS. Well, sir, our company, as I have told you, has been expanding since 1946. I have been with the company since 1949 myself. I don't know of any leisure time as far as our employees are concerned. We are all working overtime to try to do the job we have got at hand.

Our products are in great demand. For example, we have nine new plants to build, and equip by next June. That will keep us busy.

Mr. ENSLEY. On page 13, you mentioned that "during 1954 total man-hours worked were 14 percent greater than in 1950, an increase greater than the increase in our unit of production."

Mr. DAVIS. Yes, sir.

Mr. ENSLEY. Could you explain that by the fact that you are getting out a different unit product today than you did in 1950?

Mr. DAVIS. That is right. One of the problems of course that we run into is our product changes: Our products are getting more complex. Each year we do something to it to make it more competitive, and we raise horsepower the same as our competitors. But there are more work units in that product than there were 5 years ago. Consequently, our older plants are getting smaller each year for the product we have to build.

Mr. ENSLEY. Thank you, Mr. Davis.

The CHAIRMAN. Senator Watkins was unable to come back here from Utah today for this hearing, but Mr. Frischknecht, his adminstrative assistant, is here, and I wonder if he would like to ask a question.

Mr. FRISCHKNECHT. Mr. Chairman, Senator Watkins was sorry he couldn't be here today. He has been down at the National Mining Conference, where he delivered an address. He is on his way now to the National Reclamation Association Convention in the Midwest. He asked me if I could cover the hearings for him. He had some questions he wished to present to the witnesses who appeared before the committee, and my only job here today will be to present some of these questions in the hopes that we can perhaps highlight some of the testimony of the witnesses, and perhaps also gain some information for the record not contained in these statements.

Mr. Davis, what is it primarily that has brought about this thing we call automation, and the rate of introduction of these new innovations? You said something about competition; perhaps something about the fact that we may be in a buyers' market as far as your commodity is concerned. Is it that factor more than anything else which has made for introduction of automatic equipment?

Mr. Davis. I think to begin with the word "automation" is very much misused and perhaps misunderstood. I think, I like to think the first use of automation I can remember was perhaps little David when he slew Goliath with the slingshot. It was better than throwing rocks. I recall in the 1920's, when I was with Cadillac division of General Motors, our production was small, yet, we were eager just as anybody else was to save a penny per unit if we could.

Everybody was anxious to save money. At that time, I happened to be a machine designer. We were having trouble with connecting rods. We had 6 people on the job, on a milling operation and I was told to go down and take a look at the job and see what I could do to reduce the labor on the job.

It was relatively simple thing to do. I took the overarm on the milling machine and put spring clamps on it. As the worker laid the pieces on they automatically clamped themselves as they went through the cycle. That is just as true automation as we are doing today. Automation is grossly misunderstood.

Mr. Frischknecht. Isn't the evidence of that fact as far as the automotive industry is concerned, particularly your company, the indication you made with respect to the capacity of your plants, in which you are utilizing some of these automatic processes, is relatively limited, isn't it?

Mr. Davis. That is right. As I say, 6 percent of our employees.

Mr. Frischknecht. There will be some people who have suggested that one reason for the rather rapid rate of introduction of some automatic equipment has been due to labor difficulty. Has your organization experienced any type of labor difficulty in the collective-bargaining process, and so forth, which might serve as an inducement to the Ford Motor Co. to give some thought to the introduction of this type of equipment in order to eliminate certain workers and certain job processes?

Mr. Davis. No. I think that definitely has no bearing on it. After all——

Mr. Frischknecht. It hasn't been a major factor?

Mr. Davis. It hasn't been a major factor; no, sir.

You can't bury your head in the sand to progress. If a machine-tool manufacturer comes out with something better than he did last year and it saves us money, your competition is going to buy it if you don't.

Mr. Frischknecht. Isn't this essentially true also, in the automotive industry in general?

Mr. Davis. Yes; I would say so.

Mr. Frischknecht. You came out with a 202 horsepower here that is a little bit ahead of the automobile I bought a few weeks ago, much more expensive than your Ford. Isn't that part of the process here in the drive and the interest shown in automatic equipment?

Mr. Davis. Yes; I would think so.

Mr. Frischknecht. What about this matter of assistance to displaced workers? We have heard also a lot about the number of employees displaced through the introduction of this type of equipment. You indicated as far as Ford Motor Co. was concerned, it actually has affected a very small number of your employees; that all of them had been absorbed in other lines, and if not through a retraining program?

Mr. Davis. That is right.

Mr. FRISCHKNECHT. Have you folks established a definite retraining program for employees who, due to age or lack of certain abilities, are required to operate some of this equipment? Have you instituted a rather formal program and perhaps a reemployment program for those people?

Mr. DAVIS. Would you like to answer that, Mr. Donovan?

Mr. DONOVAN. In addition to on-the-job training, as we move employees from the old system and put them on the new system, special courses of instruction were developed. For example, in the engine-manufacturing operations, a machine-tool familiarization course was developed that involved presentations by 15 different machine-tool-building companies to approximately 500 job setters and job foremen. Each one of these presentations lasted for approximately 1½ hours and was intended to familiarize these key employees with the new equipment. Training courses were also developed for maintenance personnel, including courses of hydraulics, quality, lubrication, electrical and electronics, and an overall special program on automation.

Our training is developed primarily for the maintenance people and the foremen.

We experience no difficulty in moving the production workers from the old system to the new.

Mr. FRISCHKNECHT. Mr. Davis, as a result of the experience of Ford Motor Co. in this field, and of your acquaintanceship with the general problems in the automotive industry, do you believe, or do you have any reason to believe, that perhaps some type of national or Federal regulation, or legislation—not regulation, but legislation—might be desirable in terms of facilitating some of these adjustments that employees have to make? In other words, is there a problem of any real great magnitude?

Mr. DAVIS. No. I certainly don't think it would be desirable.

Mr. FRISCHKNECHT. In other words, you feel as far as you are concerned, that the Ford Motor Co. itself can take care of this problem?

Mr. DAVIS. I feel this way, sir: All you have to do is look across the water and see what they are doing in France, Germany, and England in automation. After all, we have got to compete with them, too. The Renault plant in Paris is more highly automatic than anything we have got in this country in the automotive business.

Mr. FRISCHKNECHT. I am speaking of employees of the Ford Motor Co. Do we need perhaps to increase the period during which these people might be able to draw unemployment compensation—legislate with respect to wages and hours, legislate with respect to perhaps special maintenance funds for these people during periods of retraining, or looking for new jobs or anything along that line that we need to give some thought and attention to here at the congressional level?

Mr. DONOVAN. We see no particular need at the moment for legislation along those lines.

Mr. FRISCHKNECHT. What has been the reaction of the labor organizations as far as Ford Motor Co.'s activities in this field are concerned? In the collective bargaining process, has there been any great difficulty with respect to providing perhaps with company help and assistance for these people, as a condition of labor contract?

Mr. DAVIS. None that I know of.

Mr. FRISCHKNECHT. In other words, so far as you know, the union people concerned, and with whom you deal, this is not a problem?

Mr. DAVIS. That is right, sir.

Mr. FRISCHKNECHT. Now just one or two very general questions with respect to the market for automobiles and tractors.

I certainly think it is true that farmers can't buy tractors and automobiles or anything else unless they have the wherewithal and the purchasing power to do that with, but these tractors are durable goods; aren't they?

Mr. DAVIS. Yes, sir.

Mr. FRISCHKNECHT. And they are goods which some farmers, if they take good care of them, would exercise fairly good maintenance, last a fairly long period of time.

Mr. DAVIS. That is right, sir.

Mr. FRISCHKNECHT.. Is there any reason to suspect in the light of these facts, that we ought to anticipate an increase in sales of tractors to our domestic farmers each year? For instance, our farm population is declining. Our number of farmers is declining. We have in agriculture about one-third of our farmers who produce about 85 percent of our marketable crop. These are the people who are buying the traffic. It is not the two-thirds producing little or nothing for commercial sale. We think of the number of tractors, and the number of tractors that have been sold since the end of World War II, and is there any reason to expect that farmers each year ought to buy an increasingly large number of tractors and other farm equipment?

Mr. DAVIS. I wouldn't have any opinion on that, sir. I am in no position to even hazard a guess.

Mr. FRISCHKNECHT. This matter of installment buying as it relates to the automotive industry: Don't you think perhaps that full employment, relatively high wages, which are, I think, evidenced through the fact that our consumer expenditures, the last, particularly the last, I guess, 7 or 8 years here have almost set record levels during the last 2 or 3 quarters—isn't that an evidence of the fact that a great amount of the purchasing of automobiles, et cetera, still comes from good, hard cash?

Installment buying is up, yes; but is there anything to be really concerned about? Certainly the Ford Motor Co. is concerned about sales and about the type of people buying their products, and being able to project what your sales might be. You indicated that in 1955 you thought you would build about 8 million passenger cars. By 1957 you thought perhaps 9 million. Then you folks must have given some thought and attention to where the money is coming from, will it come from credit, or wages and salaries, or just where?

Let me put my question perhaps this way: If you are anticipating selling 9 million cars in 1957, you see no danger in installment credit buying today, do you, which might lessen your opportunity to sell those 9 million cars by the automotive industry in 1957?

Mr. DAVIS. I am having trouble answering your question for the simple reason that, looking at the history of our company in the last few years, we have been able to sell everything we could produce. We have been running, in a great many instances, 6 days a week to build all we could. We are riding high, and hope to continue to ride high, because we think we have got a good product, but I can't associate any answer that I might give you with credit buying.

I know nothing of it, and am in no position to answer you.

Mr. FRISCHKNECHT. I realize that. I think perhaps these gentlemen's questions relating to the farmer and to installment buying are perhaps a little far removed from this subject matter of the hearing on automation. I know if Senator Watkins were here he would want to thank you for your very fine statement. I am only sorry he is not here personally to hear your statement.

Mr. DAVIS. Thank you.

The CHAIRMAN. Have you any estimate for 1958, Mr. Davis, for production of automobiles? 1957 and 1956, you estimated 8 million cars.

Mr. DAVIS. That is right. We think——

The CHAIRMAN. 1957, 8 million.

Mr. DAVIS. Yes.

The CHAIRMAN. What do you predict for 1958?

Mr. DAVIS. Truthfully, Congressman, I haven't looked that far ahead. I do know this: That we are planning for next year on a volume in excess of what we had this year for ourselves.

The CHAIRMAN. For yourselves.

Mr. DAVIS. We all know that this 8-million-car year which we have this year is considerably more than we thought we would have a year ago. We all thought 5½ million. Here we are selling 8 million cars this year.

Whether it will continue, I don't know. Our sales department is like any other sales department, of course. They think they are going to sell our share, at least.

The CHAIRMAN. What percentage of the automobiles are sold on installment plans?

Mr. DAVIS. I couldn't answer that question, sir. I don't know.

The CHAIRMAN. Is anyone with you in position to answer that?

Mr. DAVIS. I am afraid not.

The CHAIRMAN. But you do know without installment buying you could not market and sell 8 million cars in a year?

Mr. DAVIS. That is right, sir.

The CHAIRMAN. You are depending upon installment buying to continue as it has in the past, without any unnecessary restrictions or limitations?

Mr. DAVIS. I would think so, sir.

The CHAIRMAN. In other words, without that you could not expect to produce and sell 8 million cars next year and 9 million the next?

Mr. DAVIS. I am sure that is right. Of course the 8 million I speak of is industrywide. It isn't Ford's share by any means. We wish it were.

The CHAIRMAN. Personally I think installment buying is about the healthiest part of our economy.

Mr. DAVIS. I would think so, sir. I can remember when I was quite young, many of the things I have today I wouldn't have had unless I went out and bought them on time.

The CHAIRMAN. That is about the only way a poor fellow can save.

Mr. DAVIS. That is right.

The CHAIRMAN. Installment credit is a poor man's money and without the poor man buying you couldn't sell half the cars you do.

Mr. DAVIS. That is right.

Mr. FRISCHKNECHT. If Senator Watkins were here, I think he would want to add this comment, Mr. Chairman, that one of the healthful things he sees in the economy is the highest number of people ever employed, with the highest total wages ever paid.

Mr. DAVIS. That is right, sir.

Perhaps Mr. Donovan might want to make some comment on the increases that we have paid our hourly rate employees from 1953.

Mr. DONOVAN. Our hourly labor bill has increased approximately 45 percent since 1950.

The CHAIRMAN. Since 1950?

Mr. DONOVAN. That is right, sir.

Mr. FRISCHKNECHT. Of course, you are paying for better skilled and better trained employees.

Mr. DONOVAN. We think we have the best employees in the industry.

The CHAIRMAN. Mr. Davis, we, of course, appreciate your coming here anyway, but we particularly appreciate your coming in view of the fact that you suffered a broken arm. Thirty years ago we would have suspected that you might have gotten that broken arm cranking a private car. A lot of people then, you know, were going around with broken arms.

Mr. DAVIS. Thank you, sir.

The CHAIRMAN. We are glad we don't have to crank those cars now and don't have to park them on hills.

Mr. DAVIS. Right, sir.

The CHAIRMAN. The committee will stand in recess until tomorrow morning at 10 o'clock, at which time we will hear in this room Mr. Robert W. Burgess, who is Director of the Bureau of the Census.

(Whereupon, at 3:18 p. m., the committee adjourned to reconvene at 10 a. m. the following day, Saturday, October 15, 1955.)

AUTOMATION AND TECHNOLOGICAL CHANGE

SATURDAY, OCTOBER 15, 1955

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC STABILIZATION OF THE
JOINT COMMITTEE ON THE ECONOMIC REPORT,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Wright Patman (chairman) presiding.

Present: Representative Wright Patman, chairman of the committee (presiding).

Also present: William H. Moore, staff economist, and Grover W. Ensley, staff director.

The CHAIRMAN. The subcommittee will come to order.

Mr. Burgess, as Director of the Census, you have always been most helpful to this subcommittee in its efforts to improve the statistical program of the Federal Government, especially in respect to unemployment and related statistics.

Through all of these years the Bureau of the Census has been gaining experience with electronic computing equipment. I am told, indeed, that several of the principal types of computing machines, actually originated in the Bureau of the Census, and that the Bureau has for some decades been one of the greatest users of such equipment in the country. The Bureau has at least two of these newest type computing machines. I am sure that if we understood only a small part of what Dr. Burgess and his staff have learned about these instruments, we would be in a far better position to appraise the probable effect of automation upon office work and data-processing in the years ahead.

Mr. BURGESS. For the record, Mr. Morris Hansen, Assistant Director of the Census Bureau for Statistical Standards and immediately in charge of our electronics computing equipment, is familiar with the way it works out, and his suggestions have been incorporated in our statement, and Mr. McPherson is with Dr. Hansen, sitting on my right. He is on the same staff. He has long experience on the same line, being very close to the electronic machinery.

The CHAIRMAN. We are very glad to have you, Mr. Burgess.

You may proceed in your own way.

Mr. BURGESS. I have a prepared statement.

In the first statement I explain my participation in this work, and call attention to the fact that some of the statistics gathered by the Bureau of the Census deal with machinery; so I cover that material as well, as well as some general remarks.

I think since this matter gets somewhat complicated, and we are trying to provide a balanced point of view, I would like to present the important features consecutively. I will read through my paper, if that is agreeable to you, and then have the questions and discussion more or less afterward, although if you or other members of the subcommittee wish to interrupt at any time, that would be acceptable, of course.

The CHAIRMAN. That will be very satisfactory.

STATEMENT OF ROBERT W. BURGESS, DIRECTOR, BUREAU OF THE CENSUS, DEPARTMENT OF COMMERCE; ACCOMPANIED BY M. H. HANSEN, ASSISTANT DIRECTOR FOR STATISTICAL STANDARDS, AND JAMES L. McPHERSON, MACHINE DEVELOPMENT OFFICER, BUREAU OF THE CENSUS, DEPARTMENT OF COMMERCE

Mr. BURGESS. We have had experience with the electronic computers, as you noted.

My participation in these hearings is in response to a request dated July 12 from Mr. Patman as chairman of the Subcommittee on Economic Stabilization of the Joint Committee on the Economic Report. Mr. Patman requested my assistance in investigating the impact of automation on long-run levels of employment together with its effect upon economic stability, with special attention to the experience of the Bureau of the Census with the installation and use of electronic computing and office machines.

To satisfy this request I shall present an analysis of our experience and shall endeavor to relate this experience with these new types of mechanization to the general economic history of earlier advances in mechanization, especially the effect on employment. I also include some examination of the statistical record of the growing importance of the manufacture of machinery and equipment in the whole structure of the American industrial production, and its relationship to the growth of other industries.

While I am tempted to develop the subject by starting at a very fundamental level of basic principles, I think it will be better at this time to concentrate on exactly what is happening in connection with our present applications and to present our judgment as to the extent to which we are securing the advantages of more rapid compilation at greater accuracy and lowered cost and the extent to which volume of employment is reduced or its character modified.

CENSUS EXPERIENCE WITH LARGE-SCALE COMPUTERS

The world's first large-scale electronic computing system for data processing, the Univac, was delivered to the Bureau of the Census in April 1951, just as the tabulating load of the 1950 Censuses of Population, Housing, and Agriculture was reaching its peak. This system was capable of absorbing information from magnetic tape at the rate of 10,000 decimal digits per second, adding 11 digit numbers at the rate of 2,000 per second, comparing numbers in order to classify reports at a rate in excess of 1,000 per second, and recording the results on magnetic tape as fast as it could read in new data. Moreover, the central computer could be made to remember all the steps which had

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to be carried out in order to classify an individual's census report into all the many categories which were to be tabulated for small areas, and to carry out this sequence of steps automatically. But the auxiliary equipment which fed the data to the computer and the equipment which translated the results from magnetic tape to readable form were at that time no match for the computer in speed and reliability. Moreover, no one then had any real experience in using large-scale electronic equipment on data compiling problems. In any event, although the Univac did handle what might be considered a large job when viewed alone, it processed only a small part of the mammoth 1950 Census of Population and had very little effect on the number of people we hired, although it did help us to close out the job in a more orderly fashion because it began to take up more and more of the load as our temporary workers left the job.

By 1953, as the auxiliary equipment improved and our own experience increased, we began to use Univac more effectively on our current work. As you know, the Bureau of the Census is busy collecting a vast amount of statistical information even when it is not taking a population census. Each month we process sample information on retail and wholesale trade and on the employment status of our population, as well as on the foreign trade transactions of the United States, to name but a few of our current activities. We now use Univac to tabulate our Current Business Survey, and our Current Population Survey, and are taking steps to apply it to our Foreign Trade Statistics program. The use of this automatic equipment has not only enabled us to produce more timely statistics at lower cost, but has had the important effect of leveling off our requirements for clerical help.

Perhaps I should make clear the fact that a computer can be instructed to perform, and has the ability to carry through, any routine clerical operation, either simple or complex. Thus, it can and does do the classifying, sorting, and tabulating that are required in either sample surveys or complete censuses. With equal ease it carries through multiplications and mathematical computing in some of our sample operations. Unlike punched card equipment or manual methods, however, the large scale computers when properly instructed, carry through a whole sequence of operations without manual intervention of any sort, and with great precision as well as at high speed. The great flexibility of the machine arises because successive stages in the operations can be determined by the results obtained in preceding stages.

I have emphasized that last sentence because on some definitions of "automation," that is the key point.

A requirement to be met in applying computers is that very detailed and explicit instructions must be provided to the computer before it will proceed through any operations. A computer, for example, doesn't even know when to start or when to stop except when explicit directions covering these elementary functions are included in the instructions prepared for it. This applies not only to a complete task but to hundreds and sometimes thousands of subparts within subparts which, when executed in the proper sequence by the computer, result in the solution of a complex problem. The preparation of these lists of instructions known as programs involves specially

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trained personnel with varying degrees of skill. The personnel requirements range from the principal programers who must be thoroughly familiar with the problem to which the computer is to be applied as well as the logical system and characteristics of the computer to be used, to less skilled personnel who need know only the logical system of the computer and be capable of filling in the detailed instructions in small pieces of a total program. The less skilled personnel need not necessarily understand how the pieces they prepare fit into the large mosaic which makes the whole.

Many of the personnel needed to perform these functions of general and more detailed programing need not necessarily receive an extended education in these specialized areas. Persons of good educational background and with aptitude (but not necessarily professional training) in mathematics, sciences, engineering, and related fields or who have demonstrated ability in planning punched-card procedures can be trained in the essentials in a period of several weeks. They can acquire experience over a period of several months or perhaps a year that will enable them to perform effectively in this specialized field.

The requirement for personnel to prepare programs will be supplemented by the need for operating personnel. Much has been printed in the popular press about how automatic and self-contained these devices are. You may have heard how internal checking facilities, or checks for accuracy which are included in the instruction program, can insure against incorrect results. The very existence of these facilities establishes the fact that sometimes checks are not satisfied. When this occurs there must be human intervention by an operator. The art today has not reached the point at which the equipment can be left unattended for periods of even an hour unless the user is willing to take a great risk that during a major part of that hour the computer will just be stopped waiting for the operator to press the right button or take some other action to start it again. Because of the high cost of lost time and the need for fairly frequent operator intervention to identify and correct difficulties or supply additional input material, it is important that operators of large-scale computers be more highly skilled and trained than is necessary for more traditional office equipment.

In addition to operators there are needs for maintenance personnel. Here, as with program preparation, a wide range of skills will be required ranging from engineers who know the design of a computer to far less skilled electronic technicians who can be recruited with training in other aspects of electronics and provided specialized training on the computer in a comparatively short period of time, usually measured in months.

These requirements for personnel in the direct operation of computers are, of course, in addition to the personnel engaged in design and construction of electronic computers and components—including especially mathematicians, engineers, and other specialists as well as workers carrying out routine construction tasks.

I may interject here a personal note that I was for 28 years a statician and economist for the Western Electric Co., and I wanted to make sure that the manufacturing companies' need for people was mentioned here.

Thus, in addition to personnel required in the design and construction of computers, these new data processing facilities will create job opportunities for programers, operators, and maintenance personnel while the computers take over many clerical tasks.

Practically all of our staff working in these various types of positions represent persons with appropriate background and aptitudes who were working in the Bureau of the Census prior to our acquisition of the computer, and who have been trained and have developed the necessary experience while on the job in the Census to carry on effectively in the new type of function. We have had to hire from the outside only one or two who were already experienced in one of these fields.

For a fixed amount of work there may sometimes be a net reduction of substantial proportions of the total personnel required. The reductions, however, will be in the number of employees needed to perform routine work and any such reduction can well be a blessing in the long run, although it may cause short-run dislocations and problems that will deserve serious attention. Here, perhaps, we can draw an analogy. The modern telephone exchange is an excellent example of a specialized automatic data processing system. We supply it with some information by twisting a dial and it automatically (i. e., with the aid of elaborate "machine switching" equipment and electric circuits) selects the correct one of many thousand possible telephones to connect us with. It is difficult to imagine how many fewer telephones would be in use today if we were still dependent for this service on the pleasant voiced young lady who used to say "number please" when we picked up our receiver 30 years ago. Certainly the radical reduction of the need for the routine task which such girls performed has not resulted in insufficient opportunities for their employment in the long run.

We find that the savings through the application of computers to clerical work varies widely depending on the nature of the job. On some jobs small in size the work of preparing instructions for the computer can exceed the work required to do the job by less automatic methods. Also, some of our operations that involve only comparatively simple manipulation of data can be accomplished with greater economy either manually or on punched-card equipment than on our computer.

For example, one may have a set of records that need to be placed into sequence on the basis of an identification code, say of six digits. At the present state of development a few punched-card sorting machines that cost much less to maintain and operate than a large-scale computer can sort cards into sequence at considerably less cost than would be involved by using one of our computers to accomplish the sequencing. Jobs involving large amounts of such sorting and only limited additional operations may yield little or no gains when placed on a computer.

On the other hand, we have found that many operations can be carried through on a computer at substantially lower costs than those incurred when the work is done by the alternative methods available for use. On a number of what we regard as successful applications of the computer to the compilation of data we have found that for selected types of operations the computer has resulted in reductions of cost of from 25 to 75 percent.

I admit that is quite a range, and Mr. Hansen may be called on later to see where that can be narrowed down.

For example, about $55,000 of the funds appropriated to our Bureau for fiscal 1953 was to defray the cost of tabulating our Current Population Survey on which the Government's monthly estimates of employment, unemployment, and other characteristics of the labor force are based.

For fiscal 1955, the first full year this was done on our electronic data processing equipment, our appropriation from the Congress included about $28,000 for this same work, or just about half of what it was 2 years earlier, and a more complex tabulating job was being done. This gain is on the selected phases of the tabulation work which were transferred to the computer. Far greater gains are achieved on some operations such as mathematical computing involved in some of our sampling work, or in measuring and adjusting time series for seasonal variations. Many such operations become inexpensive and feasible that would be of prohibitive cost to carry through except on a very limited basis on alternative types of equipment.

Again, these ratios of gain are not out of line with the potential advantages of punched card equipment at the time it was being developed and introduced. The advantage or gain from the application of a computer to a job depends, of course, on the skill with which it is used, and on the state of development of computers. Advances in computer design are being made that will make computers economical for types of work for which they are not now as economical as available alternative methods.

Perhaps it will be of interest if, by describing one such application, I illustrate the types of complex but nevertheless routine clerical functions that the computers perform particularly effectively in census work.

At the present time we have two Univacs, both mainly engaged in the processing of the Censuses of Business and Manufactures. This is a complicated job involving reports from more than 3 million establishments. If these reports were all complete and self-consistent, and if we made no errors in our office work, the job of getting out the census reports would be laborious but straightforward. Unfortunately, some of the reports do contain omissions, errors, and evidence of misunderstanding. By checking for such inconsistencies we eliminate, for example, the large errors that would result when something has been improperly reported in tons instead of hundredweights. Perhaps one-third to one-half of the time our Univacs devote to processing these censuses will be spent checking for such inconsistencies and eliminating them.

As an example, let me describe one of the checks we apply to reports on the production of animal feed. In this industry practice varies among manufacturers with respect to the units they use to measure production. Some manufacturers keep production records by hundredweights and others keep such records by tons.

On the census questionnaire we requested the respondents to report production by hundredweights. We know, however, that some respondents will report tons. Because the value of the commodity is also reported to us, we can use our Univacs to detect such misunderstandings. In effect we tell our computer, in the case of this illustration, that the wholesale price value of poultry feed per hundredweight usually falls between $1.50 and $9. The Univac is instructed to compute, for each report of production of poultry feed, the average unit value and to compare this with the value range.

Obviously, if production has been reported in tons instead of hundredweights, this computation will result in an excessively high unit value. When this happens, our computer is instructed tentatively to assume that the production was reported in tons, not hundredweights, and to multiply the reported amount of production by 20—the appropriate factor to convert tons to hundredweights—and then recompute the unit value. If this recomputed unit value satisfies the check, the electronic computer has thus automatically corrected an error in reporting. If it still does not satisfy the check, our computer lists the report as one requiring inspection and correction by a subject-matter expert before we can include it in our tabulations. Such exercise of the ability to choose and to act in different ways according to conditions is, I think, a good example of automation.

Similar checking procedures are applied to the approximately 7,000 product lines for which we have reports. In a like manner we check to see whether such relationships as annual man-hours and number of production workers, or value of shipments and cost of labor and materials, are within reasonable limits for the industry and area involved.

Sometimes a respondent gives incorrect or incomplete information about the kind of business in which he is engaged and this might result in errors in the classification system on which our tables are based. Here again our Univacs are instructed to apply checks designed to detect such errors. For example, the Univac might determine for a business establishment classified as a retail shoe store that employees' salaries amount to 30 percent of total sales. For this kind of business the cost of goods purchased for resale is the major item of expense and 30 percent for salaries is uncommonly high. Our Univac would list this case for inspection, and a review of the report might result in a change in classification from "retail shoe store," to "shoe repair shop," for example.

The foregoing are simple illustrations of relationships we examine to determine the quality of reports to us. These checks are quite numerous and frequently very complex.

On the equipment available in the past it has been economical to apply only relatively simple checks automatically, and we have done the more complicated kind of checking by hiring and training enough clerks to perform these routine checks on every report. Most reports are reasonably straightforward and complete, so that a clerk may come to feel like a mere automaton, and develop a tendency to read carelessly. Now that we have now put our Univacs to work making these checks, we find them doing this sort of thing tirelessly and without forgetting any of the special rules that come into action only rarely. Later, after the tabulations are carried through, the computer will do much of the work of examining the tabulations to insure that the confidentiality of census data is maintained and the reports of individual companies are not revealed either directly or implicitly. The ability to carry through such complex procedures along with the more usual types of tabulation operations makes the computer particularly effective for some of our work.

It is not easy to identify particular jobs eliminated in connection with the application of computers to census work—many different jobs as well as machine rentals are affected. The application of our large scale computers to the continuing work of the Census Bureau—the continuing work as contrasted with the censuses as such—has made possible reductions in cost of more than $150,000 per year in the regular continuing work.

The computers, in addition, have done extensive service work for other agencies. These economies were accompanied by a reduction in our regular appropriations, although subsequently there has been more than offsetting increases to carry out expanded or additional projects. Also, we have required a substantially smaller expansion in personnel than would otherwise have been needed for processing the Censuses of Business and Manufactures that are now in progress. In addition, we expect to make results from these censuses available on a considerably more rapid time schedule.

By the time of our next decennial census in 1960, we expect that, again, automatic equipment will influence greatly not only how fast we do things but how we do them. We foresee equipment which can greatly reduce our requirements for a large staff of temporary employees to convert the information on schedules to holes in cards. In past decennial censuses we have employed several hundreds of such key punch operators. We are hopeful that in the future, there will be available equipment capable of reading marks placed on census schedules by our respondents or enumerators. Such equipment would eliminate the need for the large staff of key punch operators for a short-term job.

We also foresee the possibility that these new developments may well provide the opportunity for us to adopt certain changes in census procedures which will greatly improve the timeliness of the figures. But with these advances, there still will be a large scale clerical operation, although substantially reduced in size as compared with carrying through the same work by earlier methods.

GENERAL REMARKS ON EFFECTS OF MECHANIZATION AND AUTOMATION

Some more general remarks on the effects of mechanization and automation may now be in order.

The growth in our economy requires ever-increasing productivity from each worker. That this demand has been met is due in large part to the ingenuity of those who have developed and successfully introduced mechanical devices ranging in complexity from automatic dishwashers through mechanical harvesters to electronically controlled steel rolling mills and oil refineries. Thus our factories, farms, and homes now operate more efficiently in the sense that those who work there can spend a larger share of their effort on activities involving judgment and intelligence rather than mere brawn and muscular coordination.

One has only to compare the farm or industrial labor pattern of 1850 with that of 1950 to see that this relegation of many repetitive routine tasks to machines rather than to human beings has had a tremendous effect on our way of life. But even though there have been problems and conflict in accomplishing the readjustments that necessarily accompany the developments leading to increased productivity,

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the effect has actually been more of an evolution than a revolution. And in spite of the growing capabilities of mechanical equipment, man has always been able to make the machine his servant rather than his competitor.

Until very recently the development of machines to lighten the white collar workers' load has been overshadowed by the development of devices to relieve man's back, rather than his mind, of drudgery. Nevertheless, the typewriter, adding machine, punched card equipment, and other office devices which are now in common use were just as important developments for office work as the tractor has been to the farm.

Machines which can handle the drudgery of the office as efficiently as machines which can handle the drudgery of factory, farm, and home are now arriving on the economic scene. Does this mean that routine office workers will vanish from the streets of our cities the way that pitchfork wielding farmhands have vanished from the Mississippi Valley? Possibly, yes, but not in a few short years and perhaps not in our lifetime. We can confidently expect that advances in automation in this field will make it possible to supply types of information which have long been needed but which could not be economically provided. The transistor, the magnetic core, and the vacuum tube undoubtedly will greatly reduce the work of many large-scale clerical positions. Experience here may be similar to that when punched card equipment was introduced.

In the early nineteen hundreds, the demands for information could not be met by hand methods. This inability to meet need led to the development and introduction of punched card tabulation and accounting methods. The census played an important and leading role in this development. But the development has not displaced people—instead the lower costs and increased possibilities for timely information has made it possible to meet more of the demand for increased facts to guide decisions by American businessmen and governments.

The result of this along with other factors has been an increase in the proportion of the labor force in clerical occupations from about 3 percent in 1900 to 12 percent in 1950. Thus, there is every reason to believe that the development of cheap and versatile electronic data processing machines will not be accompanied by a major reduction, if any, in the number of office jobs.

Employment statistics support the view that, while advances in science and technology may cause declines in some areas of employment, over the long term they create greater increases in others. The number of employed persons in 1940 was 44,900,000; in 1950, it was 56,200,000—a gain of 25 percent in a period of unusually rapid scientific development.

These figures show that in spite of the installation of improved machinery, more workers were required to produce the amount of goods and services wanted. It is interesting to compare the increase in demand as well as in population with the 25-percent increase in employment during the 1940's. Measured in 1954 prices, the Nation's output of goods and services increased about 55 percent between 1940 and 1950, accompanied by an increase of 15 percent in population.

The gain in employment is interesting because as the decade began many people were concerned about machines displacing men. And it is especially interesting that some of the industries that introduced new machines employed substantially more people in 1950 than in 1940. The telephone industry, for example, which put in the dial telephone and displaced many operators, nearly doubled its employment between 1940 and 1950.

Over the 10-year period, workers shifted from one industry to another and from one occupation to another. Some of these shifts, no doubt, resulted from the introduction of machines. For example, there was a marked drop in employment on farms and in private households. Much of the work formerly done manually in these places is now done more efficiently by machinery either in shops or on the farm or in the home.

Where did the farm and household workers go? If they did not drop out of the labor force, they probably went into the industries where employment was expanding. Manufacturing had an increase of 4 million workers, 38 percent; wholesale and retail trade an increase of 3 million, 40 percent; and services outside private households had an increase of 2,700,000, 35 percent.

Specific industries with the largest increases were: retail trade; construction; professional and related services; public administration; manufacturing of machinery; wholesale trade; transportation; metal manufacturing; finance, insurance, and real estate; repair services; and telecommunications.

Increases in some of these industries appear to be directly related to increases in many parts of the economy in the use of automatic equipment. For example, increases in professional services, in machinery manufacturing, in metal manufacturing, and in repair services can fairly be ascribed, at least partially, to an increase in the demand for persons to design, manufacture, and repair automatic equipment for applications in many different types of activities.

Shifts in occupational groups are particularly interesting. The major declines were in farmers and farm managers, farm laborers, and private household workers. Substantial increases, on the other hand, were recorded for semiskilled operatives, for clerical workers, and for skilled craftsmen and foremen. Smaller increases occurred in nonfarm managers, officials, and proprietors, in professional and technical workers, in service workers outside private households, and in sales workers. All of these are higher-paying occupational classifications than laborers and private household workers, so it appears that opportunities for more desirable jobs have been created.

Since 1950, employment has continued to increase, according to figures from the Census Bureau's Current Population Survey. The number of agricultural workers has further declined. The greatest increases have been in professional and technical workers, in semiskilled operatives, and in skilled craftsmen and foremen.

A long-range view of the growth of employment in the machinery industries is given by the Censuses of Manufacturers and the Census Bureau's Annual Survey of Manufactures. Manufacturing has taken tremendous strides since 1900, and the machinery industries have progressed faster than the average. I have tables and a chart at the end of this statement that points these items up.

In 1899, some 4½ million production workers were employed in manufacturing industries. In 1953, three times that number worked in manufacturing, although population had only doubled between 1900 and 1950. The machinery industries showed even greater gains. In 1899, some 400,000 production workers were employed in the machinery industries; in 1953 more than five times that number were so employed. In 1899, production workers in the machinery industries were about 9 percent of the production workers in all manufacturing industries; in 1953, they had climbed to 16 percent. The manufacture of machinery and equipment has thus grown in importance within the whole structure of American industrial production.

Largely because of the record of past changes and the accompanying circumstances as I have observed them, I do not expect the further development of machines to reduce the number of jobs over the long term. Furthermore, in my judgment, the new jobs will be less arduous, more satisfying to the individual, and better paying. Not only have new types of machines resulted in increased production, but they have enabled us to make more goods in fewer hours of work so workers have had more opportunity to engage in recreational and cultural activities. These in turn have created further demand for goods and services. The characteristic effects of new machinery on production and employment in the past seem to me very similar in the main to what we are currently seeing for electronic computers and can reasonably expect in the future.

The Bureau of the Census will very soon publish statistics from the 1954 Censuses of Agriculture, Business, Manufactures, and Mineral Industries. These censuses should provide a wealth of information which will show substantial progress in the production, use, and effects of laborsaving machinery.

SUMMARY

In summary, I believe that automation applied to data processing may well be accompanied by a net increase in the overall demand for workers as well as an improvement in the opportunity for the worker to make fuller use of his talents. There seems to be no reason to expect a change in the historical pattern of growth of demand for work output more than offsetting the reduction of man-hour requirements to accomplish the work originally required. Our country appears to be in an era of rapid growth. The development of new industries, the increasing productivity, the growth of the population, the average citizen's desire for new products and more old products, the widespread business confidence, the recognition of responsibility by the Government to promote sound economic growth under the Employment Act of 1946, all promise a continuous expansion of our economy.

Although automation may lead to some serious short-run dislocations in particular industries and particular parts of our country, it seems to me that, in the long run, it will facilitate and promote the general expansion.

As has happened in the past, personal requirements while unchanged in total may undergo changes in types of assignments. This can create real problems which call for skillful handling and understanding of human relations as well as economic problems in making the adjustment between the different types of workers required on the new and the old bases. It is obvious that the organization that tried to adopt a hard-boiled attitude toward its original workers would lose in workers resentment and public disapproval as well as in loss of related knowledge and skills that can be converted for valuable application in the new areas.

I think we can say that "automation" is a new word for a now familiar process of expanding the types of work in which machinery is used to do tasks faster, or better, or in greater quantity. For a century or so we have been adjusting to more and more mechanization. We have thrived and grown great partly because of this, certainly not in spite of it.

(The charts referred to above are as follows:)

Production workers in machinery industries and in all manufacturing industries, 1899–1953

[In thousands]

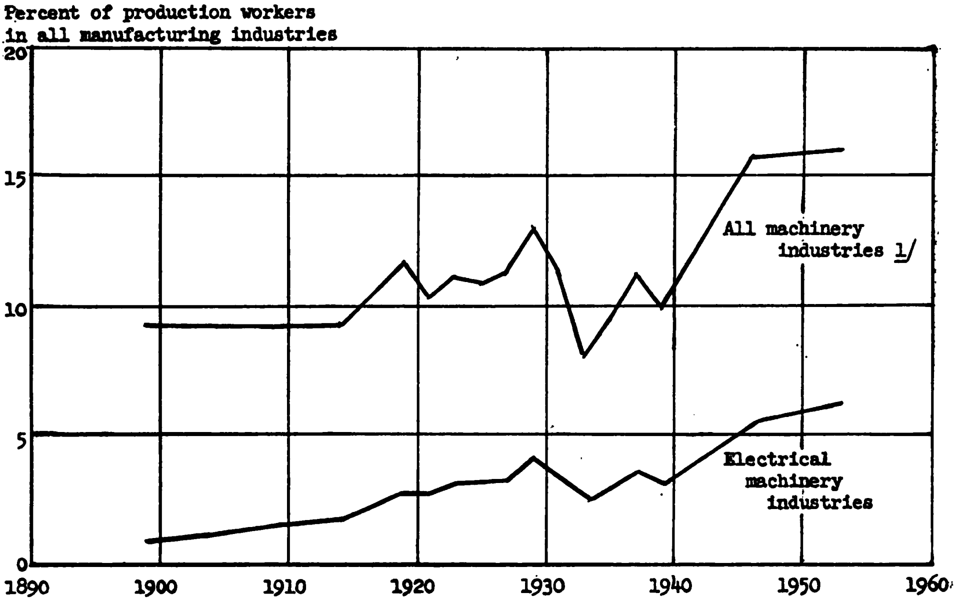
Year	Total manufacturing	Machinery industries					
		Total		Electrical machinery		Other machinery [1]	
		Number of production workers [2]	Percent of total manufacturing	Number of production workers	Percent of total manufacturing	Number of production workers [2]	Percent of total manufacturing
1953	13,501	2,158	16.0	851	6.3	1,307	9.7
1947	11,916	1,883	15.8	639	5.4	1,244	10.4
1939	7,808	784	10.0	248	3.2	536	6.8
1929	8,370	1,091	13.0	343	4.1	748	8.9
1919	8,465	998	11.8	241	2.9	757	8.9
1909	6,262	568	9.1	92	1.5	476	7.6
1899	4,502	414	9.2	43	1.0	371	8.2

[1] Includes engines and turbines, tractors and farm machinery, machine tools, textile machinery, pumps and compressors, office and store machines, sewing machines, etc.

[2] Figures for 1899–1929 are not entirely comparable with those for 1939–53, largely because the earlier figures include boiler shop products and foundry products. These industries were not classified in machinery industries after 1931.

Source: U. S. Bureau of the Census, Census of Manufactures, 1899, 1909, 1919, 1929, 1939, 1947. 1953 Annual Survey of Manufactures. Figures for total machinery industries for 1899-1929 compiled by Harry Jerome from the Census of Manufactures and published in Mechanization in Industry (National Bureau of Economic Research, 1934), p. 232.

PRODUCTION WORKERS IN MACHINERY INDUSTRIES AS PERCENT OF PRODUCTION WORKERS IN ALL MANUFACTURING INDUSTRIES, 1899-1953



1/ Figures for 1899-1931 are not entirely comparable with those for 1933-1953, largely because the earlier figures include boiler shop products and foundry products. These industries were not classified in machinery industries after 1931.

Sources: U. S. Bureau of the Census, Census of Manufactures, 1899, 1904, 1909, 1914, 1919, 1921, 1923, 1925, 1927, 1929, 1931, 1933, 1935, 1937, 1939, 1947. 1953 Annual Survey of Manufactures. Figures for all machinery industries for 1899-1929 compiled by Harry Jerome from the Census of Manufactures and published in Mechanization in Industry (National Bureau of Economic Research, 1934), p. 232.

The CHAIRMAN. That is a very fine statement. We appreciate it very much, Mr. Burgess. I notice you have a table there. Do you want to explain that?

Mr. BURGESS. Yes. The table accompanies the remarks, where I made some comments as we went along. On page 14, we show production workers in machinery industries and in all manufacturing industries, comparing the period 1899 to 1953. The years are years in which we have had censuses of manufacturers, and we have the figures in thousands, total production workers in manufacturing on the left. Then for the machinery industries, the first two columns, total number of production workers in the machinery industries and the percents.

Those columns show year by year the total in manufacturing. The growth is summarized clearly in the percent figures, from 9.2 in 1899, rising pretty steadily, a dip in 1939, to be sure, to 16 percent in 1953. The electrical machinery in the next two columns parallels that, with a growth even greater, as I said before. This is my line. It used to be my line. One percent in 1899 to 6.3 percent in 1953. The other machinery has grown. Perhaps the most interesting point there is notes 1 and 2, indicating the wide range of types of other machinery that there are, including engines, turbines, tractors, farm machinery, machine tools, textile machinery, pumps and compressors, office machines, sewing machines, and so forth.

That is the machinery used in carrying on the work of the country, and attention is called to the wide variety used in activities outside of manufacturing. The chart on page 15 brings out graphically the same information as in the table, a general upward trend, irregular in spots, in the percent of production workers in all manufacturing industries who are engaged in all machinery industries, and in electrical machinery industries, as shown by the two curves.

The CHAIRMAN. From the chart it appears that in the early thirties, the number of machines in use went down considerably.

Mr. BURGESS. That is the percent of production workers making machinery.

The CHAIRMAN. That would reflect the expansion or lack of expansion on the part of the all industry, would it not?

Mr. BURGESS. Of the manufacturing industry. As an instance of the decline, I sent in the reports to the Census Bureau for 1931 and 1933 for the Western Electric Co. As a matter of fact, I was not then in the Census Bureau, of course. I got a question as to the 1933 report of the Hawthorne plant of that company: "Is this the same plant that you reported in 1931?" The differences were so enormous. A major activity in 1931 was the job of producing machine switching equipment for the telephone industry. Activity of the company as a whole fell off so far that employment dropped below 18,000 in early 1933, whereas it had been up around 85,000 at the end of 1929. That is what happens in a depression. The number of people engaged in producing machinery——

The CHAIRMAN. The swing was more violent than in other industries

Mr. BURGESS. More violent, I think, in all capital goods industries. That is generally recognized by people who analyze the business cycle.

(The following table was subsequently supplied to supplement this point:)

Average number of production workers in metalworking machinery (industry group No. 354), 1927–53, and in machine tools (industry No. 3541), 1919–53

Year	Metalworking machinery (industry group No. 354)		Machine tools (industry No. 3541)	
	Number of workers (in thousands)	Index of workers (1947=100)	Number of workers (in thousands)	Index of workers (1947=100)
1953	234.0	135	76.8	140
1952	225.7	130	79.5	145
1951	199.3	115	64.0	117
1950	149.0	86	41.6	76
1949	139.5	81	38.6	70
1947	173.0	100	54.9	100
1939	81.0	47	37.0	67
1937	[1] 80.2	52	[1] 37.5	68
1937	[1] 90.2	46	[1] 47.3	86
1935	51.3	30	28.2	51
1933	25.5	15	12.7	23
1931	38.8	22	21.3	39
1929	74.1	43	47.4	86
1927	49.3	28	[2] 32.4	59
1927	--------	--------	[2] 35.3	64
1925	--------	--------	30.8	56
1923	--------	--------	33.4	61
1921	--------	--------	21.3	39
1919	--------	--------	53.1	97

[1] The smaller figure excludes data for establishments engaged primarily in manufacturing rod and wire forming and fabricating, rolling mill, sheet-metal-working, and wire drawing machinery and is comparable with figures for later years. The larger figure includes data for these establishments and is comparable with figures for earlier years.

[2] The smaller figure excludes data for establishments primarily engaged in manufacturing machine tool accessories and is comparable with figures for later years. The larger figure includes data for these establishments and is comparable with figures for earlier years.

Source: U. S. Bureau of the Census, Annual Surveys of Manufactures, 1949–53, and 1947 Census of Manufactures, Vol. II. Data for years prior to 1939 compiled by Solomon Fabricant from the Census of Manufactures and published in Employment in Manufacturing, 1899–1939 (National Bureau of Economic Research).

The Chairman. Which year did you have 45,000 workers?

Mr. Burgess. In 1921 or 1922. After World War I there was a big expansion. That is the time of the installation of the machine-switching equipment around New York City, and so forth.

The Chairman. What was the number about 1930?

Mr. Burgess. At the end of 1930, as I recall, it was around 63,000 or something like that.

The Chairman. What was it, say, in 1933?

Mr. Burgess. Under 18,000 in the first half of 1933.

The Chairman. From 63,000 in 1930 to 18,000 in 1933?

Mr. Burgess. That is my recollection. I notice you have some people from the telephone industry that are going to appear later. They will have their records right at hand. It was a tremendous decrease. At one plant location, Kearny, N. J., the number of all types of employees dropped from 22,000 to 3,000 or under 3,000.

The Chairman. From 22,000, say, in 1930, to about 3,000 in 1933?

Mr. Burgess. Yes. In January 1930 was the peak.

The Chairman. That was the high mark?

Mr. Burgess. Yes, sir.

The Chairman. What was the low point?

Mr. Burgess. For this plant, I think 2,200, or something like that.

The Chairman. I mean the low point in time.

Mr. BURGESS. Well, the first few months of 1933, as I remember.

The CHAIRMAN. How much did it cost the Bureau of the Census to install these Univac machines?

Mr. BURGESS. Well, the first one was something under a million dollars, as I recall.

Mr. HANSEN. In round numbers three-quarters of a million.

Mr. BURGESS. The cost went up after this original purchase.

The CHAIRMAN. That was about 1951; was it not?

Mr. HANSEN. Yes, although the contract was made for the equipment somewhat before that.

The CHAIRMAN. Was this on a leased basis or purchase basis?

Mr. BURGESS. That was a purchase basis.

The CHAIRMAN. It was not from IBM?

Mr. BURGESS. No. This was another company.

The CHAIRMAN. Does IBM furnish some of your machinery?

Mr. BURGESS. Yes. We rent from IBM quite a lot of equipment regularly.

The CHAIRMAN. Do you know of any reason why IBM leases, and you can purchase from the others?

Mr. BURGESS. That is the standard procedure. I don't know; does anybody lease from Remington Rand?

Mr. HANSEN. Remington Rand will either rent or sell equipment.

Mr. BURGESS. IBM will not sell.

Mr. HANSEN. In general, that is true.

The CHAIRMAN. What are the other companies that handle this kind of equipment, the big companies, besides IBM and General Electric?

Mr. BURGESS. Sperry Rand.

Mr. MCPHERSON. RCA is supplying some equipment of this type. There is Electro Data Corp., the National Cash Register people, and then there are maybe a hundred small companies. We could supply a list. I can't recall the names.

The CHAIRMAN. That is enough.

Do they all lease or sell except IBM?

Mr. MCPHERSON. I don't think I know.

The CHAIRMAN. IBM is the only one that you know that exclusively deals with the leasing?

Mr. MCPHERSON. I know that IBM has that policy. Whether RCA and National Cash Register and others will adopt the policy, I don't know.

The CHAIRMAN. What does it cost to operate these machines, say, for an hour, per day; that is, these large computers?

Mr. HANSEN. We operate them, these two machines combined, for about $35 an hour.

The CHAIRMAN. $35 an hour?

Mr. HANSEN. I am sorry. This is the cost per machine.

The CHAIRMAN. That is the cost per machine. That doesn't include the pay for the people who operate them or anything like that?

Mr. HANSEN. This does include the pay for the people. The total cost of operating, including the management staff for the operation itself, and the maintenance of the equipment. It does not include the capital cost, any charge for capital cost of the equipment or for space or power.

The CHAIRMAN. You have machines that are put out, I assume, by Remington Rand and by IBM that compare pretty well. Are they about the same type of machine? They do about the same thing?

Mr. BURGESS. You say "we have." We don't happen to have any IBM electronic, large-scale computer.

The CHAIRMAN. How would these lease arrangements compare in cost to purchase arrangements? In other words, what kind of a payout would you have on lease arrangement?

Mr. BURGESS. We had our original contract for the second Univac, set up on a lease-purchase arrangement, and it became clear when we were able to get the funds in connection with these large economic censuses that it was definitely more economical to purchase than to lease.

The CHAIRMAN. To purchase than to lease?

Mr. BURGESS. Yes.

Mr. HANSEN. If I might add a point there, Dr. Burgess, we operate our machines 24 hours a day, 7 days a week, both of them, and when you operate on this very full scale, the advantage of purchase over rent is particularly great, and in this case, we figured that in a period of 3 to 4 years, if one purchased, he would—well, if one took the rentals and put them into purchase, it would take a period of 3 to 4 years of rentals to convert to a purchase; that is if you applied them to purchase in the first place.

The CHAIRMAN. How long are they good for, 15 or 20 years?

Mr. HANSEN. Well, except for obsolescence—they are good indefinitely. The maintenance policy is such as to continue them in operation indefinitely. The only time one would take them out of service is when new equipment comes to the point where it pays to substitute new equipment for the old.

The CHAIRMAN. If you were to make an estimate of the additional cost of leasing, as compared to buying, what would you say the additional cost would be?

Mr. HANSEN. I don't know how to answer that question, except perhaps in the terms I already did: by buying, say, after 3 or 4 years, we effectively get the equipment rent free. Rentals cost, depending on how much you operate and what particular pieces of auxiliary equipment you are using with the main computer, and if you are operating 24 hours a day, 7 days a week, rentals on equipment such as we have for 1 machine, with accompanying auxiliary equipment, will run around, as I remember it, around $400,000 a year.

Mr. MCPHERSON. I was going to say $380,000.

Mr. HANSEN. $412,000 is the number I remember, but I am not sure.

Mr. BURGESS. May I suggest, Mr. Chairman, that at this point perhaps we could file something for the record?

The CHAIRMAN. I wish you would, Mr. Burgess. That would be very interesting.

Mr. BURGESS. We need to cover these different alternatives, the various rates of activity.

(The information is as follows:)

The following information comparing rental with purchase is based on our rental-purchase contract with Remington Rand, dated September 9, 1954, for

a Univac with six Uniservos and our experience in maintaining our first computer.

Alternative rental plans:	
Annual rental for Univac with 6 Uniservos:	
(*a*) for operation 1 shift a day 5 days a week	**$205,260**
(*b*) for operation 3 shifts a day 7 days a week	**411,900**
Purchase plan:	
Price of Univac with 6 Uniservos	**783,000**
Annual cost of maintenance when purchase plan based on our experience:	
(*a*) for operation 1 shift a day 5 days a week	**60,000**
(*b*) for operation 3 shifts a day 7 days a week	**90,000**

Under either plan installation was an additional $89,440. No printer, card-to-tape, or other auxiliary equipment was included in this contract.

As anticipated, we have operated our 2 computers 3 shifts per day 7 days per week since they were installed and expect to continue operating on this basis.

The CHAIRMAN. Answer the question as well as you can, please.

Mr. BURGESS. Yes.

The CHAIRMAN. Mr. Burgess, I want to ask you, do you have at your fingertips the farm population as it has increased in the last few years?

Mr. BURGESS. I don't think I recall precisely. We have a report on that, and it has decreased in the last 5 years between 1950 and 1955 census. I think it is something in the order of 5 million decrease.

The CHAIRMAN. Perhaps I should write you a letter on that, Mr. Burgess.

Mr. BURGESS. We can give you the figure on that.

(The information is as follows:)

Estimated farm population in the United States, 1910–55

Year (April)	Millions of persons	Percent of total population	Year (April)	Millions of persons	Percent of total population
1955	22.2	13.5	1930	30.5	24.9
1950	25.1	16.6	1925	31.2	27.0
1945	25.3	18.1	1920	32.0	30.1
1940	30.5	23.2	1915	32.4	32.4
1935	32.2	25.3	1910	32.1	34.9

Source: Estimates prepared jointly by the Bureau of the Census and the Agricultural Marketing Service and published in Series Census–BAE, No. 16 and Census–AMS, No. 21.

The CHAIRMAN. I am interested in the farm population and I have some other questions which you can supply the information if you please.

Mr. HANSEN. May I make one more remark on the comparison of rental and purchase? I think your point that we should supply this information later is well taken, but I would like to make a comment amending what we said before about rental versus purchase. If it costs about $400,000 a year to rent, and something approaching $100,000 a year that we have to pay to maintain our own equipment, that should be subtracted from that, so that one would think of something of the order of $300,000 a year after you have paid for it.

The CHAIRMAN. After about the third or fourth year you would be saving about $300,000 a year. You would have to deduct from that the replacement of parts.

Mr. HANSEN. This hundred thousand I mentioned takes care of replacement of parts.

The CHAIRMAN. You would save some $300,000 a year after a few years?

Mr. HANSEN. If you operate 24 hours a day, 7 days a week. We will supply the information, but I didn't want to leave that wrong impression.

The CHAIRMAN. Mr. Moore, do you have some questions?

Mr. MOORE. Mr. Burgess, would it be possible to explain so that a layman could understand the great technological break, the great technological difference between the familiar old-fashioned punchcard setup and this new computing machine? Is one of the mechanical or semimechanical or are they both more or less dependent upon electrical contacts?

Mr. BURGESS. They are radically different bases. Perhaps Mr. Hansen can give you that.

Mr. HANSEN. Probably Mr. McPherson can give most briefly and effectively the difference.

Mr. MCPHERSON. I think there's maybe two parts: One, the brilliant realization that a vacuum tube could compute by just being either on or off; and secondly, the newer equipments contain their control elements internally and operate on the instructions, the same as they operate on data, so that consequently, for any item of information that one of these new devices wants to look at, and process, it is permitted to keep that item of information in effect in front of it, so it can be looking at it.

The old punchcard equipment was all geared to a fixed cycle. The card came into place, it stayed there for a fixed period of time. It never varied. It didn't make any difference whether you wanted to do a lot or a little. You only had so much time. The new equipment lets you devote as much time to any piece of information as you chose to. Therefore, you can have long, complex operations for one item of information, something very simple for the next, and the machine takes a long time on the one, a short time on the other.

I don't know whether that is simple or not.

Mr. MOORE. But the introduction of the punchcard some years ago was itself a revolutionary thing in office work.

Mr. MCPHERSON. Indeed, yes. We are very proud that that was invented at our Bureau.

Mr. MOORE. Then this introduction of electronic computers is sort of the second revolution which data processing has gone through in a lifetime.

Mr. MCPHERSON. Except that I agree with the Director, it is more evolution. I don't really think it was revolution when the punchcard came in, although I wasn't at the Bureau. The device has been improved in the last half century, and as Dr. Burgess said, we use more people rather than less, probably because we get out more data rather than less.

We get it out much more efficiently than we did before.

Mr. MOORE. I notice, Mr. Burgess, that you referred to the fact that in the early introduction of these new computers, no one then had any real experience with them, and so you didn't get the utmost out of them. You then point out that as your own experience increased, you were able to get additional information from them. To what extent was the new knowledge, experience, and development dependent upon the users like yourselves as opposed to that supplied by the manufacturers?

In other words, did you in the Census learn because your own technicians learned new uses for these machines, or to what extent were these pointed out to you?

Mr. BURGESS. It became both. I came with the Census Bureau in February of 1953. Mr. Hansen can answer that more fully, to show the development of it.

Mr. HANSEN. I am sure the manufacturers have been of tremendous assistance in pointing out both ways of using this equipment, but I think the answer to your question is essentially that we have had to ourselves develop the types of applications and how to apply equipment to these applications.

Mr. MOORE. So that the Government, through the Census, has made a genuine contribution to the advancement of this science or technology?

Mr. HANSEN. Census and others working with the equipment.

Mr. MOORE. You don't have to be modest about it.

Mr. HANSEN. I think Census as well as the manufacturers and others.

Mr. MOORE. Of course, not only Census, but other Government departments that have used and helped develop these machines.

Mr. HANSEN. Yes, sir. Bureau of Standards certainly has had a leading role in this.

Mr. MOORE. One other question: Is there any difference in what you might call the "mix" of personnel, that is the relative number of supervisors, foremen, and chief clerks, clerks, and so forth, after you have installed one of these machines, than you would have had before? In other words, in an old office setup there were junior clerks, clerks, chief clerks, strawbosses, and others. Is the proportion of experts any greater relatively in an automated setup or is it about the same mix?

Mr. BURGESS. My view of it is that the proportion of experts and the degree of expertness has been raised very substantially in this and other developments.

Mr. HANSEN. I think that is right.

Mr. MOORE. I wondered, Mr. Chairman, if Dr. Burgess could submit a summary table of some kind for us here in reference to the statement that increased employment has appeared in some parts of the economy at the same time that others have been decreasing as the result of use of automatic equipment.

Professor Buckingham yesterday cited a study which he said showed that in 12 cases of automation, ranging from chocolate refining to railroad traffic control, the reduction of employee requirements averaged 63.4 percent. I imagine there might be other industries that have expanded as a consequence of the increased use of automatic equipment. If you have such tables, can you furnish those?

Mr. BURGESS. We will review what we can find from our information.

(The following was subsequently supplied for the record:)

The following four tables present rankings of industries according to percent change in employment from 1940 to 1950. The first table lists the major industry groups. This is followed by three tables which rank the individual industries within the sectors of (1) durable-goods manufacturing, (2) non-durable goods manufacturing, and (3) transportation. The four tables show the rela-

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tive growth in total employment in the respective industries. These data do not provide a measure of the extent or growth of automation in each industry. The Census Bureau does not have any statistical information from which such a measurement can be obtained. The table, however, will permit rough judgments to be made on the relation between automation and employment, on the basis of independent knowledge as to the extent to which automation has been applied in particular industries. For example, telecommunications, which has been among the pioneers in the use of automatic equipment and has greatly expanded its use since 1940, showed one of the largest percentage gains in employment over the 1940–50 decade. Presumably the reduction in cost of the services made possible by automation was a factor in the increased demand for the services.

Ranking of major industry groups by 1940–50 percent change in employment

Major industry group	*Percent change, 1940–50*
Public administration	77.0
Telecommunications	75.0
Construction	65.8
Wholesale trade	64.0
Business and repair services	58.4
Manufacturing, durable goods	51.6
Professional and related services	42.1
Utilities and sanitary services	41.4
Retail trade	35.2
Transportation	34.5
Entertainment and recreation services	32.1
Finance, insurance, and real estate	30.1
Manufacturing, nondurable goods	27.1
Total employed	25.3
Forestry and fisheries	14.6
Personal services, except private households	12.5
Mining	1.7
Agriculture	−18.0
Private households	−29.7

Source: U. S. Census of Population, 1950, vol. II, pt. 1, table 56.

Ranking of durable goods manufacturing industries by 1940–50 percent change in employment

Industry	*Percent change, 1940–50*
Aircraft and parts	140.0
Electrical machinery, equipment, and supplies	112.9
Agricultural machinery and tractors	101.5
Professional and photographic equipment and supplies	78.3
Miscellaneous machinery	77.0
Office and store machines and devices	66.4
Cement, and concrete, gypsum, and plaster products	60.1
Clocks and miscellaneous manufacturing industries	58.5
Nonferrous-metal industries	54.1
Motor vehicles and motor-vehicle equipment	52.1
Total, durable-goods manufacturing	51.6
Pottery and related products	44.2
Iron and steel industries, except steelworks	44.0
Railroad and miscellaneous transportation equipment	43.3
Furniture and fixtures	42.7
Glass and glass products	36.8
Sawmills, planing mills, and millwork	34.4
Miscellaneous nonmetallic mineral and stone products	26.9
Total, employed	25.3
Logging	21.5
Blast furnaces, steelworks, and rolling mills	21.3
Structural clay products	15.1
Miscellaneous wood products	9.0
Ship and boatbuilding and repairing	2.6

Source: U. S. Census of Population, 1950; vol. II, pt. 1, table 131.

Ranking of nondurable goods manufacturing industries by 1940–50, percent change in employment

Industry	*Percent change, 1940–50*
Miscellaneous paper and pulp products	121.3
Drugs and miscellaneous chemicals	65.2
Paperboard containers and boxes	62.2
Canning and preserving fruits, vegetables, and sea food	60.7
Rubber products	49.8
Miscellaneous fabricated textile products	47.1
Petroleum refining	45.5
Dairy products	39.7
Miscellaneous food industries	37.9
Printing, publishing, and allied industries	35.0
Apparel and accessories	34.7
Paint, varnishes, and related products	32.5
Meat products	30.3
Grain-mill products	29.5
Notal, nondurable goods manufacturing	27.2
Total, employed	25.3
Carpets, rugs, and other floor coverings	24.8
Beverage industries	23.3
Leather products, except footwear	17.7
Dyeing and finishing textiles, except knit goods	14.7
Bakery products	13.0
Pulp, paper, and paperboard mills	12.0
Miscellaneous petroleum and coal products	11.8
Yarn, thread, and fabric mills	9.9
Confectionery and related products	9.7
Footwear, except rubber	8.7
Synthetic fibers	4.5
Miscellaneous textile mill products	—4.4
Leather: tanned, curried, and finished	—4.8
Knitting mills	—10.7
Tobacco manufactures	—13.8

Source: U. S. Census of Population, 1950, vol. II, pt. 1, table 131.

Ranking of transportation industries by 1940–50, percent change in employment

Industry	*Percent change, 1940–50*
Air transportation	323.9
Taxicab service	95.2
Warehousing and storage	76.7
Street railways and bus lines	45.5
Services incidental to transportation	44.9
Trucking service	36.7
Total, transportation	34.5
Total, employed	25.3
Railroads and railway express service	22.2
Water transportation	15.6
Petroleum and gasoline pipelines	12.6

Source: U. S. Census of Population, 1950, vol. II, pt. 1, table 131.

The CHAIRMAN. Mr. Ensley.

Mr. ENSLEY. Mr. Burgess, will you give us a little more information on the method of retraining and the experience you have had at Census?

Mr. BURGESS. I will refer to my colleagues on the steps on that. Do you want to take it, Mr. Hansen?

Mr. HANSEN. I might make a remark on it and ask Mr. McPherson to remark on it. I might say Mr. McPherson was the person who had the lead role in connection with getting the staff trained that the Census applied to this computer when we first acquired it. I did want to emphasize the point that you made in the paper, Dr. Burgess, that we have something of the order of perhaps 50 people working on this computer, with differing degrees of specialized training, most of them rather highly specialized training, and yet I think it is fair to say that perhaps only 1 of these came from the outside in the sense that he came trained on the computer as an expert before he came to us. We were able to train people, and some of them in advance of the actual acquisition of the computer, prior to the time that we put it in operation and during the time we have had it in operation, so that we have drawn from our own staff, or people comparable to people on our staff. There has been turnover and outside recruiting. I think the different techniques of training have differed a great deal, whether it is operators, programers, or engineers.

Would you like to comment more specifically on the training, Mac?

Mr. McPherson. I think you have covered all of it, perhaps, except this training of programers. I sometimes describe our use of this equipment as being a little like a laundromat, in the sense that we keep the equipment in operation, and the subject matter people in our Bureau, the people responsible for the Current Population Survey, in our Population Division, for the Current Business Survey in our Business Division, and so on through the other subject matter specialties, bring their work to it. They assume much of the responsibility for programing. They come and bring their work to the machine. It only takes a matter of a few minutes to stop one kind of work and start another.

The training of the people that have done much of this programing has been successful, and very short—a matter of only a few months, as the Director says. The important ingredient to success is not learning how to program for the equipment, but knowing and understanding the problem.

These people will maybe have spent years becoming specialists in employment and unemployment statistics, and only a matter of a few months to become familiar with the computer itself. The important ingredient is understanding of the problem, and learning the computer is almost self-training for many of our intelligent people.

Mr. Hansen. If I can add a remark to that to supplement the training in another respect. I think that our experience, since we were the first in this field with the Univac, the computer, may be perhaps different than that of those who more currently acquire the equipment. Most of our training was on-the-job training, with only a few people, a comparatively small proportion spending periods of a month or two in formal training classes, supplied by the manufacturer. A few of our people have had this sort of training. Most of them have learned on the job, without that formal sort of training, but more or less formal training and on-the-job work, right with us.

Mr. Ensley. Your agency has been, more or less, the pioneer. We read in the paper last night of the Treasury introducing new equipment for processing checks. Is there any need, or perhaps there is in existence a central retraining program that the Civil Service

Commission has created? Would there be any need for that, or can it be completely decentralized and performed by the agency involved?

Mr. **Hansen**. Some of the colleges in the area are giving training in some aspects of computers, and in other parts of the country.

Mr. **Ensley**. I am thinking of the fellow who has been writing it by hand, and his job has been taken over by machine and you have the problem of retraining that person to either work that machine or do some other job.

Mr. **Hansen**. I would prefer to turn to Mr. McPherson, again. My opinion is Civil Service would not do too much for that person when it comes to installation of equipment.

Mr. **McPherson**. I would feel pretty much the way Mr. Davis and his colleagues felt yesterday, that the operation is pretty easy, to change the operator from one machine to another. The specialized training, that which takes longer, will be in the maintenance and engineering side. This, obviously, will be specialized to particular pieces of equipment so I would doubt that the Civil Service would do this.

There is, in my opinion, in this area of processing, a possibility that in this Treasury application, for example, where they have a continuing workload—at Census we have these peaks and valleys, so that it is how many people we employ for a big job, not where do we find work for displaced people, but in this Treasury application they may find that they need fewer operators.

There might be some desirability for programs of some sort designed to equip those displaced people to do other jobs, whether or not those other jobs would be in the same agency.

Mr. **Ensley**. Is the Civil Sedvice Commission taking note of these technological developments?

Mr. **McPherson**. I have a feeling they can't help themselves, because we are their customers, in a sense, and one of our problems is getting the people that we have working on this equipment classified at the levels that we think they should be classified, so certainly some people at the Civil Service Commission are aware of that.

Mr. **Burgess**. May I put in a comment there, because even though this involves admitting that we do have discussions and "hassles" in the Census Bureau, this matter of recruiting people for our growing requirements, the second Univac, led to some divergence of view between Mr. Hansen's organization and our personnel people who have to deal with the Civil Service.

Hansen said we wanted some good people, and they admittedly have difficulty at this stage in writing out specifications that fit into the ordinary Civil Service mold, and the Civil Service people have grades written out with levels of pay, which seem to us hard to mold, to take account of the new requirements that are coming along, and perhaps it can be recognized they are difficult to put down to print. Therefore, to get back to the point I commented on as we went along, these requirements are for able people, for example, people who are trained in mathematics. As indicated in my earlier experience, in the first 10 years out of graduate school I was teaching mathematics, largely to freshmen engineers, at different institutions, and I know the difference in capacity of the different students that come along, or different people that come along, and it is very conspicuous, especially in the mathematical line.

I think from what I observed here it sticks out when you get on the various levels of work, in using electronic computers, and I think actually it is applied also in using IBM equipment. Those people are sifted out. It isn't merely a matter of training or organization procedure. It is a matter of recognizing the inherently different capacities of different individuals and getting the right people for the jobs.

Mr. Hansen. If I can add to that point just briefly, you were raising the question about training earlier. A part of our problem, especially earlier while getting our equipment going, arose out of the fact that the people we got and trained were lost to industry. We spent quite a little time training some of them before we got the machine, and this training turned out not to do the Government any good. We were unable, because of the Civil Service system and the rules and regulations we were working under, to keep these people.

We trained and supplied them to industry, in effect, without getting any benefit from them. This is still what was happening a little more recently in connection with what the Director referred to. We had some serious problems keeping personnel. We are beginning to see some solutions, some of them by using other channels than getting around Civil Service. I think this is still a real problem still with us.

Mr. McPherson. There is still great competition for these skills, and when private industries buy one of these devices, it is pretty easy to go to the Government to find a readymade, trained employee.

Mr. Ensley. I have one more question, Mr. Burgess.

Countries have differing types of organization for gathering and disseminating statistics. In many countries statistics are gathered by one central office. In this country the function is decentralized and performed by the operating agencies. Your agency is one of these gathering agencies. Are there any implications of this new electronic equipment which suggest whether a central office is more efficient? Would there be any economy, so to speak, because of the automatic equipment, to having a central statistical office?

Mr. Burgess. I think in the compilation end in this country, and in others, it ought to be planned to have large enough units to take advantage of this. That is, the unit which we have, or the two Univacs—two of these large computers working together, we believe, is a more efficient setup and more efficient system than having one working part time in one place and another working elsewhere. That doesn't mean that in the United States Government necessarily they all have to be in one unit, but in big enough units, so as to get the efficiency of the full-time use of the big items.

Mr. Hansen. If I could make a comment, related to that point: We have indicated we have two Univacs, which we do have, but actually we bought one and three-quarters computers. The Internal Revenue Service bought one-fourth of our second computer. They were planning initially to proceed to rent a computer at the same time we were exploring the possibilities of getting a second computer. We got together with them and found by joint operation we could make very real gains for us as well as economies for them, as compared with renting their equipment. It was their joining in and buying a fourth of our second computer that made it possible, with the resources we had within the framework of these censuses to actually buy our computer to do the censuses, and both of us have achieved very substantial gains. I think it is working most satisfactorily from the point of view of both agencies.

Mr. ENSLEY. So that you can, on a decentralized basis, through interagency transfers and cooperation, accomplish the economies that you would ordinarily expect in this type of development, without centralizing everything in one.

Mr. HANSEN. I think we can.

Mr. BURGESS. It doesn't need to be centralized at the top. This part of the operating end needs to be brought together.

Mr. MCPHERSON. Mr. Hansen said that we spent about $35 per hour per Univac. We had only one Univac for a period of almost 4 years, and as I recall, when we were operating only one, our costs were about $45 an hour.

Mr. HANSEN. That is about right. There are real economies in the combined operation of the computers.

Mr. ENSLEY. Thank you.

The CHAIRMAN. Thank you gentlemen very much. You have been very helpful. We appreciate it.

Without objection, we will stand in recess until Monday morning.

Mr. BURGESS. Mr. Chairman, the suggestion is if the chairman or members of the committee or Mr. Moore, Mr. Ensley, and other staff members would like to come out and see our Univacs, we would be glad to have you.

The CHAIRMAN. We have in mind asking you to give us the time when we can visit your place. We will do that later. Thank you.

(Whereupon, at 11:15 a. m., the committee recessed, to reconvene at 10 a. m., Monday, October 17, 1955.)

AUTOMATION AND TECHNOLOGICAL CHANGE

MONDAY, OCTOBER 17, 1955

Congress of the United States,
Subcommittee on Economic Stabilization of the
Joint Committee on the Economic Report,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Wright Patman (chairman) presiding.

Present: Representative Wright Patman, chairman of the subcommittee (presiding).

Also present: William H. Moore, staff economist, and Grover W. Ensley, staff director.

The Chairman. The subcommittee will please come to order.

This morning we are privileged to hear Mr. Walter Reuther, who is head of the United Auto Workers, and since 1952 president of the Congress of Industrial Organizations.

Mr. Reuther, we are glad to have you this morning, and we always profit from your testimony. We are always glad to hear from you. So you may proceed in your own way, if you wish.

STATEMENT OF WALTER P. REUTHER, PRESIDENT, CONGRESS OF INDUSTRIAL ORGANIZATIONS; ACCOMPANIED BY DON MONTGOMERY, DIRECTOR, WASHINGTON OFFICE, UNITED AUTOMOBILE WORKERS OF AMERICA; AND NAT GOLDFINGER, ASSOCIATE DIRECTOR OF RESEARCH, CIO, WASHINGTON, D. C.

Mr. Reuther. Thank you, Mr. Chairman.

First, I should like to express my appreciation for the opportunity of appearing here, and I would like to congratulate your subcommittee for conducting these very extensive studies of this developing problem of automation.

Mr. Chairman, I have a prepared statement which I should like to enter into the record, and I would like to elaborate on it orally.

The Chairman. It will be inserted.

(The statement is as follows:)

I should like first of all to express my thanks to this subcommittee for the opportunity to testify on automation and to congratulate its members for calling these hearings.

One of the essentials of a strong and effective democracy is that we have leaders who attempt to anticipate situations which may arise and prepare in advance to deal with them. Too often in the past, nations have been surprised unnecessarily by economic and social dislocations. In the 18th and 19th centuries, for example, the first industrial revolution brought untold hardships to millions of families in Great Britain, partly because Britain at that time lacked both the economic knowledge to understand and control the forces at work and the democratic institutions of government through which the people could have called attention to their needs. In our own country, had we understood the economic forces that were eating away at the base of our apparent prosperity in the 1920's we surely would have been able to build safeguards into our economy that could have protected us from the collapse that followed.

In the spread of automation and the prospective large-scale industrial use of atomic energy—and the possible practical utilization of solar energy, as well—we are faced with mighty forces whose impact on our economy can be vastly beneficial or vastly harmful, depending on whether we succeed or fail in achieving economic and social progress that will keep pace with changing technology.

The willingness of this subcommittee to study these technological developments, and to look squarely at the potential problems they may create, gives hope that this time we will not be caught unaware. It gives us hope, too, that we may be able to foresee the threat of dislocations and take action in advance to enable us to enjoy the benefits of a new abundance, without first having to pay a heavy price in unemployment and human suffering.

AUTOMATION—A REVOLUTIONARY DEVELOPMENT

We have been told so often that automation is going to bring on the second industrial revolution that there is, perhaps, a danger we may dismiss the warning as a catch-phrase, and lose sight of the fact that, not only the technique, but the philosophy of automation is revolutionary, in the truest sense of the word. Automation does not only produce changes in the methods of manufacturing, distribution, many clerical operations, and in the structure of business organization, but the impact of those changes on our economy and our whole society bids fair to prove quite as revolutionary as were those of the first industrial revolution.

Through the application of mechanical power to machinery, and the development of new machinery to use this power, the first industrial revolution made possible a vast increase in the volume of goods produced for each man-hour of work. Succeeding technological improvements—such as the development of interchangeable parts and the creation of the assembly line which were essential to the growth of mass production industries—have led to continuous increases in labor productivity. But however much these machines were improved, they still required workers to operate and control them. In some operations, the worker's function was little more than to feed the material in, set the machine in operation and remove the finished product. In others, proper control of the machine required the exercise of the highest conceivable skills. But whether the required skill was little or great, the presence of a human being, using human judgment, was essential to the operation of the machine.

The revolutionary change produced by automation is its tendency to displace the worker entirely from the direct operation of the machine, through the use of automatic control devices. No one, as far as I know, has yet produced a fully satisfactory definition of automation, but I think John Diebold came close to expressing its essential quality when he described automation as "the integration of machines with each other into fully automatic, and, in some cases, self-regulating systems."

In other words, automation is a technique by which whole batteries of machines, in some cases almost whole factories and offices, can be operated according to predetermined automatic controls. The raw material is automatically fed in, the machine automatically processes it, the product is automatically taken away, often to be fed automatically into still another machine that carries it automatically through a further process. In some cases the machine is self-regulating—that is, it is set to turn out a product within certain tolerances as to size or other factors, and if those tolerances are exceeded, the machine itself detects the variation and automatically adjusts itself to correct it.

The revolutionary implications of this new technology can best be understood by looking at a few examples of what is actually being done through automation today, in scattered parts of the economy.

THE LATHE THAT REPLACES ITS OWN TOOLS

The application of automation ranges all the way from individual automatic machines to virtually automatic factories.

An example of the first is an automatic lathe, produced by the Sundstrand Machine Tool Co., described in American Machinist, March 14, 1955, page 117, which gages each part as it is produced and automatically resets the cutting tools to compensate for tool wear. In addition, when the cutting tools have been worn down to a certain predetermined limit, the machine automatically replaces them with sharp tools. The parts are automatically loaded onto the machine and are automatically unloaded as they are finished. These lathes can be operated for 5 to 8 hours without attention, except for an occasional check to make sure that parts are being delivered to the loading mechanism.

AN AUTOMATIC PLANT

A completely automatic plant is now producing mixed and ready-to-use concrete for the Cleveland Builders Supply Co. (Business Week, Apr. 16, 1955, p. 80). Operated from an electronic control panel, the plant can produce and load into ready-mix trucks any one of some 1,500 different mixing formulas that may be demanded. This plant uses no manual labor at any point in the process.

By a combination of teletype and radio, the control operator is informed as to the particular formula to be loaded into each truck as it arrives. He gets out a punched card, coded for that formula, and the automatic mechanisms take over. Specified amounts of the required materials are delivered by conveyors, in precisely the right quantities, to a mixing bin where they are automatically mixed and then loaded into the waiting truck. The control mechanisms even measure and compensate for any deficiency or excess of water in the aggregate (sand, coarse rock, slag, etc.) which goes into the mixer, and if the order calls for a dry mix, the materials are automatically routed through a dry spout.

This automatic plant has a capacity of 200 cubic yards of concrete per hour, as against 100 cubic yards per hour in the company's conventional plants.

THE AUTOMATIC BROACHING MACHINE CUTS DIRECT LABOR COSTS DRASTICALLY

An automatic two-way horizontal broaching machine for machining automobile cylinder heads has cut direct labor costs between 1949 and 1954 by more than all the technological improvements made in this process during the previous 35 years—and with an actual decline in the investment required (Instruments & Automation, January 1955, p. 111).

In 1914 the Cincinnati Milling Machine Co. would have used 162 machines, representing an investment of $243,000, to machine 108 cylinder heads per hour at a direct labor cost of 40 cents per piece. By 1949 it took six machines, representing an investment of $240,000, to turn out the same volume of production at a direct labor cost of 20 cents per piece. (The saving in man-hour requirements is much greater than indicated by these figures, when the increase in wage rates between 1914 and 1949 is taken into account.)

By 1954, however, those six machines had been replaced by a single automatic machine, representing an investment of only $230,000, for the same volume of production, and direct labor costs had been cut from 20 cents a piece in 1949 to 4 cents a piece in 1954—a reduction of 80 percent in 5 years.

MERELY CHANGE THE TAPE TO CHANGE THE JOB RUN

One of the important features of automation is that it can be applied not only to long runs of identical operations, but to fairly short-run jobs where instructions given to the machines have to be changed at the end of each job. This is made possible through the use of printed tape, punch cards, etc., on which the instructions are coded, and the machine is given a new set of instructions simply by changing the tape or card.

Minneapolis-Honeywell Regulator Co., for example, reports (Wall Street Journal, April 22, 1955) the development of a precision boring machine, used in aircraft equipment production, which can bore holes with an accuracy of one-thousandth of an inch. Electronic signals from a tape move the blank metal back or forward, rotate it into position, and then turn on the boring mechanism to cut the hole exactly where it is desired. The machine is specially suited for medium-size production in lots of several hundred parts.

RUNNING A BANK WITH AN ELECTRONIC COMPUTER

The use of automation is not restricted to manufacturing plants. Increasingly, so-called electronic brains are taking over the functions of office clerks, accountants, and other white-collar workers.

Stanford Research Institute has produced for the Bank of America (Fortune, October 1955, p. 131) an electronic computer which will do the jobs of many employees. When a check comes to the bank, an operator merely punches into the machine the amount on the face of the check. The check itself carries a code, printed in magnetic ink, which identifies the account number. The machine scans this code to identify the account. It then refers to its "memory bank," which contains information on 32,000 separate accounts, makes sure there is enough in the account to meet the check (if there is not a warning "overdraft" light is blinked at the operator's desk), and deducts the amount of the withdrawal from the account. The machine also checks up to make sure that there is no stop-payment order against the account. The whole operation takes approximately 1 second.

The transaction is recorded, first in a "temporary memory" bank, and is transferred later to a "permanent memory" bank. At the end of the month, the computer automatically calculates the service charge and then, connected to a high-speed printer which can print 800 characters a second, it prints the customer's complete monthly statement in less than 5 seconds. It is claimed that 9 operators and 1 such machine can replace up to 50 bookkeepers.

Similar computers are being used to make up payrolls, to prepare insurance premium notices and record payments, to prepare telephone bills, to take inventory, to control the operation of electric power generating plants, and for many similar purposes. One central computer to be installed by the Ohio Edison Co., for example, will simultaneously control the operations of 35 generators in 9 plants scattered over an area of 9,000 square miles (New York Times, August 18, 1955).

Even automation itself is being automated. One of the bottlenecks in the use of computers to which data is punched cards has been the time required to have the information punched on the cards by trained operators. Now the Burroughs Corp. has produced for the First National City Bank of New York (Wall Street Journal, June 17, 1955) an electronic device which "reads" the serial numbers on travelers' checks and reproduces them on punched cards at a rate of 7,200 checks per hour, doing the work of 10 highly skilled operators.

The great variety of applications shown in these few examples illustrates one of the most significant features of the new technology—its wide applicability. That is the real quality that makes automation a genuinely revolutionary force in our economy, rather than just another technological improvement.

It is technically possible to apply the feedback principle of automation, and the servomechanisms which implement it, to virtually every situation where human control of industrial processes is now used. The growing flood of new uses of automation indicates how quickly the economics of its application are being worked out.

EVEN ROUTINE TECHNOLOGY IS ACCELERATING

One of the factors which has been responsible for the steadily increasing rate of productivity since World War II has been the enormous increase in research expenditures both by industry and by Government. Alfred North Whitehead, the British philosopher, once said, "The greatest invention of the 19th century was the invention of the art of inventing." We might add that one of the great developments of the 20th century has been to change inventing from an art to a standard business procedure. The research department is now a fixture in every important corporation, while the needs of government, especially in national defense, have added to the numbers of research workers, many of whose discoveries are readily applied to industry.

As a result, the flow of what may be considered routine technological innovations—new production methods, new materials and machines applicable only to specific processes or industries, and improvements in work flow—has been greatly accelerated. Harlow Curtice, president of General Motors, noted recently that "new products, new processes are coming off the drawing boards of the engineers and out of the laboratories of the scientists at ever faster pace."

This great expansion of industrial research, and the flood of routine technological innovations it produces, have been sufficient, alone, in recent years, to boost the rate of rising productivity to the extent that past notions of what were normal productivity increases are already obsolete. Technological improvements of this sort, and on an increasing scale, can be expected to continue. By themselves, they would pose serious problems of adjusting our economy so as to provide sufficient purchasing power to absorb the steadily accelerating flow of goods which can be produced with every man-hour of labor.

"WE ARE MERELY ON THE THRESHOLD OF THE TECHNOLOGICAL AGE"

Beyond these routine technological improvements, however, we are now confronted with the potentially explosive impact of automation, and we can be sure that this new technology, too, will grow by leaps and bounds.

In discussing the rapid advances of technology, David Sarnoff, chairman of the Radio Corporation of America, stated in a pamphlet entitled "The Fabulous Future."

"The quantity of new powers and products and processes at man's disposal is important; but even more important is the increasing speed at which these things have come. It is not a case of continued increase but of continued acceleration of increase. We need only project the trend into the future to realize that we are merely on the threshold of the technological age."

Summing up the potential impact of the new technologies, Mr. Sarnoff says:

"The very fact that electronics and atomics are unfolding simultaneously is a portent of amazing changes ahead. Never before have two such mighty forces been unleased at the same time. Together they are certain to dwarf the industrial revolutions brought about by steam and electricity."

ORGANIZED LABOR WELCOMES AUTOMATION

What is the attitude of the trade-union movement, and specifically of the CIO, to this new technology of automation?

First of all, we fully realize that the potential benefits of automation are great, if properly handled. If only a fraction of what technologists promise for the future is true, within a very few years automation can and should make possible a 4-day workweek, longer vacation periods, opportunities for earlier retirement, as well as a vast increase in our material standards of living.

At the same time, automation can bring freedom from the monotonous drudgery of many jobs in which the worker today is no more than a servant of the machine. It can free workers from routine, repetitious tasks which the new machines can be taught to do, and can give to the workers who toil at those tasks the opportunity of developing higher skills.

BUT WE CANNOT SIDESTEP ITS PROBLEMS

But in looking ahead to the many benefits which automation can produce, we must not overlook or minimize the many problems which will inevitably arise in making the adjustment to the new technology—problems for individual workers and individual companies, problems for entire communities and regions, problems for the economy as a whole.

What should be done to help the worker who will be displaced from his job, or the worker who will find that his highly specialized skill has been taken over by a machine What about the businessman who lacks sufficient capital to automate his plant, yet has to face the competition of firms whose resources enable them to build whole new automatic factories? Will automation mean the creation of whole new communities in some areas, while others are turned into ghost towns? How can we increase the market for goods and services sufficiently, and quickly enough, to match greatly accelerated increases in productivity?

Finding the answers to these questions, and many others like them, will not be an easy process, and certainly not an automatic one. Even if the greatest care is taken to forsee and meet these problems, adjustments for many people will prove difficult and even painful. If there is no care and no foresight, if we subscribe to the laissez-faire belief that "these things will work themselves out," untold harm can be done to millions of innocent people and to the whole structure of our economy and our free society.

The CIO insists that we must recognize these problems and face up to them. But our recognition that there will be problems, and serious problems, to be solved, does not mean that we are opposed to automation. We are not. We fully recognize the desirability, as well as the inevitability of technological progress. But we oppose those who would introduce automation blindly and irresponsibly, with no concern for any result except the achievement of the largest possible quick profit for themselves.

When the first industrial revolution took place, no effort was made to curb or control greedy, ruthless employers. Businessmen took advantage of unemployment to force workers to labor 12 and 14 hours a day for a pittance so small that not only wives, but children scarcely out of infancy, had to enter the factories to contribute their mite to the family earnings. The benefits which we today can so readily recognize as the fruits of the first industrial revolution were achieved only after decades of privation, misery, and ruthless exploitation for millions of working people.

Most of us find it difficult to believe that the second industrial revolution—the automation revolution—can possibly produce similar results. But if vast social dislocations are prevented this time it will be only because the combined social wisdom of private groups and government will be used to prevent them.

We now know that the greatest good of society is not served by permitting economic forces to operate blindly, regardless of consequences. We now know that economic forces are manmade and subject to controls, that the economic and social consequences of economic decisions can be forseen, and when the consequences threaten to be harmful, preventive action can be taken. That philosophy is expressed, however imperfectly, in the Employment Act of 1946. We recognize today that it is not only possible, but necessary, for the Government to analyze, to foresee and to give direction to the economic forces that determine whether we shall have prosperity or depression.

Unfortunately, there are those who refuse to admit that automation poses any problems for individuals and for society as a whole. More unfortunately still, they are the very people who should be in the best position to foresee the difficulties that will have to be met, and in cooperation with Government and the trade unions, to take action to meet them. Their spokesman is the National Association of Manufacturers. Their attitude has been all too clearly expressed in a pamphlet issued by the NAM entitled "Calling All Jobs." This pamphlet recognizes, and indeed elaborates on, the parallel between the first industrial revolution which ushered in the machine age and the second industrial revolution which today is ushering in the age of automation. But with almost inconceivable blindness to the facts of history, the NAM completely disregards the misery and suffering that accompanied the introduction of the machine age, and dismisses all the protests of workers of that day as unfounded complaints.

The workers of 150 years ago who tried to smash the machines that had taken away their jobs had ample foundation for their complaints. They were wrong only in their methods. Their real complaint was not against the machines, but against the blindness of society which allowed the machines to be used as a means of ruthless exploitation.

MAGIC CARPET ECONOMICS ARE NOT GOOD ENOUGH

We, in the labor movement today, have no complaint against the new technology of automation. We do not intend to let ourselves be misrepresented as opponents of automation. What we do oppose is the spirit of the NAM and those of like mind, whose views are expressed in the closing sentences of the pamphlet previously referred to:

"Guided by electronics, powered by atomic energy, geared to the smooth, effortless workings of automation, the magic carpet of our free economy heads for distant and undreamed of horizons. Just going along for the ride will be the biggest thrill on earth."

We do not believe that any thinking person is prepared to accept the NAM's magic-carpet theory of economics. Automation holds the promise of a future of new abundance, new leisure, and new freedoms, but before that future can be achieved there will be many serious and difficult problems to be solved. We do not believe that the American people or the Congress are prepared to just go along for the ride.

MANY PROBLEMS CAN BE FORESEEN

Let us consider some of the specific problems that will have to be met. One of the major problems is that no one as yet has made a thorough study of what has been done in the field of automation, what is being planned for the near future, or what impact it has had or will have on our lives. As a result, an exhaustive list of the problems that automation will pose does not yet exist.

There are some problems, however, which can be foreseen. Obviously, there will be problems for the workers who are displaced from their jobs by automation. This is not merely a problem of finding a new job. One point on which most of the writers on automation seem agreed is that, by its very nature, automation will tend to eliminate unskilled and semiskilled jobs, while the new jobs it creates will be at a much higher level of skill. As one spokesman for the Ford Motor Co. has put it: "The hand trucker of today replaced by a conveyor belt might become tomorrow's electronic engineer."

That sounds very nice, but it immediately poses the problem: How does the hand trucker become an electronics engineer—or a skilled technician? If automation destroys unskilled jobs and creates skilled jobs, means must be found to train large numbers of unskilled workers in the needed skills.

Another aspect of the same problem is that of the worker with a specialized skill who finds that his skill has been made valueless because a machine has taken over his job—such as the skilled machine operator displaced by a self-operating lathe or the bookkeeper whose job is taken over by an electronic "brain."

You can easily see that if automation is going to displace any substantial number of workers in either of these two ways, we will need a carefully organized retraining program to give them the opportunity of acquiring the skills they will need. Such a program must take into account the needs of the workers, the fact that most of them will be mature men and women to whom the learning of new skills may not come easily, and that they have to live and support their families while they are acquiring these skills. The program will require not merely training facilities and expert vocational guidance. It will have to include provision for training allowances to replace lost wages during the training period.

Without such a program, there may be a job as an electronics engineer for the hand trucker's son, but the hand trucker himself may have to join the ranks of the unemployed—one of a "lost generation" of workers who will have been scrapped as ruthlessly as so many items of obsolete equipment.

"HE COULDN'T KEEP UP"

An alternative solution will have to be found in the case of older workers, not old enough for normal retirement, but too old to learn new skills or to adjust to the demands of the new technology. A single instance will be enough to point up the problem. This is from a report in the New York Post:

"Then there are workers who can't keep up with automation. Such as Stanley Tylak. Tylak, 61 and for 27 years a job setter at Ford, was shifted from the River Rouge foundry machine shop to the new automated engine plant. He was given a chance to work at a big new automatic machine.

"Simply, straightforwardly, he told his story: 'The machine had about 80 drills and 22 blocks going through. You had to watch all the time. Every few minutes you had to watch to see everything was all right. And the machines had so many lights and switches—about 90 lights. It sure is hard on your mind.

" 'If there's a break in the machine the whole line breaks down. But sometimes you make a little mistake, and it's no good for you, no good for the foreman, no good for the company, no good for the union."

"And so Stanley Tylak, baffled by the machine he couldn't keep up with, had to take another job—at lower pay."

This was a case where automation resulted in downgrading—not the upgrading so widely heralded by industry spokesmen as one of the fruits of automation. Yet in one sense Stanley Tylak was lucky. He at least was able to take another job. In many cases there will be no other jobs available for a man in his sixties or even younger. Perhaps if Stanley Tylak had been given more than just a chance to work at the new machine, perhaps if he had been given careful training for the job, taking into account the difficulties of adjustment to a new job at his age, he could have learned to do it even at 61. But for those older workers who cannot adjust, I think we must be prepared to offer the opportunity of early retirement with the assurance of an adequate pension.

In some of our collective bargaining agreements we have already laid the foundations for a system of early retirement which could help to meet such situations. But in the very nature of most private pension plans the problem cannot be solved through collective bargaining alone. Industrial pension plans are based on the assumption that the worker, when he retires, will also be eligible for social security benefits. Much as we have improved the level of private pensions in recent years, a worker who is forced to retire before the age of 65 would find it impossible to maintain a decent standard of living on his industrial pension alone. I would strongly urge this committee to consider, in formulating its recommendations, the need for earlier social security payments to workers who are forced into retirement before the age of 65 because technological changes have taken their jobs from them and their age makes it impossible for them to find other work.

COMMUNITY DISLOCATIONS

The growth of automated factories can create problems of dislocation not only for individual workers but for whole communities. It is often cheaper to build a new plant from the ground up, so that the whole design of the buildings can be related to the industrial processes, than to attempt to remodel an existing plant. In addition, corporations frequently seem to prefer to employ on automated processes workers who have had no experience with older methods. Thus an employer whose only concern is his own profit may decide that it is to his advantage to build a new plant in a new location, perhaps hundreds of miles away—without any consideration for the old community.

Automation is not the only technological change which may produce such shifts in industry. The large-scale conversion of atomic energy into electric power in quantities sufficient to supply the needs of industry is now an assured possibility which will become a reality within relatively few years. A more far-reaching possibility exists in the direct conversion of energy from the sun, which has already been developed to the point of successful use in applications requiring small amounts of power. Such developments can provide limitless new sources of power for industry, but they can also produce severe dislocations and shifts in the geographical distribution of industries.

Many of the large industrial centers in our country today owe their location to ease of access to coal or other power sources. With the advent of new power sources the advantages of such locations may disappear and large-scale movements of industry to new areas may well take place.

Let me make it clear that we are not opposed to such changes when they are based on sound economic and social considerations. Such changes are part of the long-run dynamic economic growth, upon which the advance of prosperity depends. But it would be foolish to deny that changes of this sort will produce their own problems.

Special assistance will be needed to prevent the spread of distressed communities and there will be innumerable questions to be answered. When important industries move out of town, for example, what can be done to replace them with others? Should workers be encouraged to move to a new community, and if so, what help will they need in relocating themselves? When the movement of industry means a sudden burst of expansion for some communities, or perhaps the creation of brandnew towns and cities, what help will they need in the way of housing programs and the building of schools, hospitals, and other community facilities?

Even today, there are scores of distressed communities in our Nation, where hundreds of thousands of workers have been left stranded by shutdown plants, industry migration, closed coal mines, and curtailed operations of railroad repair shops. The impact of automation will possibly create additional pockets of substantial unemployment, even if high-employment levels are maintained nationally.

Government assistance is required to aid in solving the pressing problems of such communities at present; Government assistance has not yet been forthcoming, despite campaign promises that were made in the fall of 1952. Additional Government aid will be needed in the future, as the new technology becomes widespread.

These are existing problems that result from the accumulation of routine technological change. Are we going to permit their multiplication and aggravation during the period of the widespread introduction of automation?

LONG-RUN MOBILITY IS NOT GOOD ENOUGH

There is a tendency among management spokesmen, including some management-oriented economists, to dismiss these problems with the phrase "mobility of labor." Workers who are displaced from their jobs in one community, so the argument runs, will simply move to another community where workers are needed and jobs are plentiful. Some have even suggested that proposals like the guaranteed annual wage, or other measures designed to cushion the shock of readjustment, are harmful because they interfere with the mobility of labor.

As any study of real life situations, like Professor Miernyk's Inter-Industry Labor Mobility, will show, for a substantial proportion of workers no real mobility exists. Because of financial obligations, family responsibilities, strong community ties, or simply because they are too old to hope to find new jobs, they continue to cling to their home communities.

In the long run, of course, the labor market will show a high degree of mobility, because in a stranded community, the older workers will eventually give up the search for nonexistent jobs and retire from the labor market, and few younger workers will move in to take their place. But that concept of mobility represents merely the use of statistics to camouflage the reality of a myriad of individual tragedies.

Even to the extent that labor is mobile, we know that such mobility can be achieved only at a price—the cost of retraining, the cost of moving and rehousing, etc. Those who consider that all of management's responsibilities can be made to disappear by invoking the term "mobility of labor" take it for granted that working people should be prepared to bear all the risks and pay all the costs of economic changes which destroy their jobs. Such an attitude is both irrational and irresponsible. As Prof. Walter S. Buckingham of Georgia Institute of Technology has said:

"There is no reason why labor should be more mobile, flexible and willing to assume the enormous risks of economic dislocation than the other components of production—capital, management and natural resources—which are to varying degrees organized, concentrated and immobilized. Indeed sacrifices made by other factors of production in participating in a competitive market are ordinarily much less than those made by labor * * *. The worker has not his, or someone else's, money at stake, but his life, and his children's lives, on the auction block of the commercial market."

THE EMPLOYER'S RESPONSIBILITY

Although most of the needed help will have to come from governmental agencies, we should also give serious thought to the responsibility of business itself in attempting to solve these problems.

I have said that we welcome dynamic growth in our economy, even while we recognize the problems that such growth may bring. But we must not permit business to excuse irresponsible actions with the claim that, "this is part of the process of dynamic growth." The shutting down of a plant, the displacement of thousands of workers, the dislocation of whole communities, cannot be justified simply because a corporation accountant can show that the potential profits to the corporation are greater than the direct costs reflected in the corporation's books.

In the program for a guaranteed annual wage, toward which the trade union movement has taken a long first step this year, one of our objectives has been to curb irresponsible action on the part of employers by requiring them to pay some of the social costs of policies which result in unemployment. In the same way, consideration should be given as to whether the costs of helping individual workers to adjust to the changes produced by automation should be borne by society as a whole, or whether some means should be sought to insure that the employers will bear a share of the burden.

For example, if the result of automation is that a large number of workers in a plant have to learn new skills, I believe it is just as reasonable to expect the employer to pay the cost of retraining, including the payment of wages during the retraining period, as it is that he should pay the cost of building the new plant or installing the new equipment. When a plant is moved to a new locality, I believe the employer has a responsibility, not merely to retrain those workers who wish to move with the plant, but also to bear at least part of their cost of moving and new housing. These are just as much costs arising out of the employer's business decision, as the business costs he now takes for granted.

This is primarily a matter for collective bargaining, but I feel the committee should be aware of it. In our experience with employers—and it has been considerable—the one sure way of making them socially responsible is to make them financially responsible for the social results of what they do or fail to do.

AUTOMATION AND EDUCATIONAL NEEDS

The transition to the new technology will require a great expansion in our education system. As I have already noted, there seems to be general agreement that one of the results of automation will be a substantial raising of the level of skills required in automated factories and offices. That will require, in turn, a vastly improved program of vocational education to train young people in the new required skills, as well as to retrain the present working force for the responsibilities in automated operations.

I want to emphasize, however, that it is not enough to provide merely the physical facilities—the schools, the teachers, the teaching equipment. It is equally necessary that students should have the economic means to delay their entry into the labor market so as to pursue their studies and training. Even today there are far too many young people dropping out of school before they should, simply because they and their families are not in a position to make the financial sacrifices that would be involved in their continuing at school. We need a greatly expanded program of financial aid to students through scholarships, and as the level of skill required in the factories of tomorrow rises, that need will be greatly intensified.

With the spread of automation, there will be a growing need for specialized semiprofessional technicians, as well as for professional engineers and skilled workers. The education system of the Nation should be preparing now to meet these requirements.

I have made particular reference to the need for an improved program of vocational education because it ties in directly with the needs of automated factories and offices for workers with new skills. But we should not stop there. One of the benefits we should expect to gain from the great increases in productivity that automation makes possible is not only a reduction in hours of work—and I shall return to that subject in a few moments—but a reduction in the years of work. That reduction can be partly achieved by making it possible for more young people to continue their education in whatever field they choose and are fitted for. To meet the needs of our people, we require today far more teachers, doctors, nurses, and members of other professions than are now entering our schools to train for those professions.

We are dangerously short of engineers, especially at a time when in Russia the school system is being deliberately oriented toward the education of vast numbers of engineers as a necessary basis of further industrial expansion. Professional training apart, we should make it one of the major goals of our society that every young person will have not only the physical opportunity but the economic means to gain the fullest education of which he or she is capable.

AUTOMATION AND THE NATIONAL ECONOMY

So far I have been dealing primarily with the impact of automation on individuals and on local communities. But even more serious consideration must be given to its possible impact on the economy of the Nation as a whole.

From the viewpoint of the national economy, the greatest problem posed by automation is the threat of violent fluctuations in employment and production during the period of adjustment to the new technology. With the widespread introduction of automation speeding up the potential output of goods and services, there is the possibility that markets may not grow fast enough to sustain high employment levels.

I am not reassured by those who tell us that all will work out well in the long run because we have managed to live through radical technological changes in the past. Human beings do not live long enough for us to be satisfied with assurances about the long-run adaptation of society to automation. And while it is true that radical technological improvements have been introduced in the past, it is well to remember that they were accompanied by vast social dislocations, recurring depressions, and human suffering.

Most of us remember the depression of the 1930's only too well, when the American people paid a heavy price for the economy's failure to adjust to the introduction of mass production after World War I. We should now be thinking about and planning for the transition period—the next 10 years or so—when the spread of automation may result in dislocations of our society and in distress for countless individuals and communities.

Our economic needs will be rising in the years ahead. The population, it is expected, will increase from approximately 165 million at present to about

190 million 10 years from now. The number of households will rise from about 48 million now to an estimated 56 million in 1965. But the increase of economic needs does not mean that these needs will be filled automatically, adjust market demands to the rising output of goods and services, made possible by the new technology. We are compelled to rely, instead, on our own wisdom or lack of it, and upon our private and public policies.

If the national economy expands with sufficient rapidity in the coming decade or two, along with the widespread introduction of automation, the problems posed by the new technology will be minimized and localized. But economic expansion does not arise simply because we desire it. Economic growth is the product of expanding markets that make possible the profitable utilization and further expansion of productive capacity.

Even under normal conditions, the national economy is compelled to expand on a continuing basis if high levels of production and employment are to be maintained. In a year when the civilian labor force is some 62 to 64 million, as in the recent past, the economy is burdened with the responsibility of providing over 3 million new job opportunities, when productivity rises 4 percent and the labor force increases by some 700,000. In other words, we have to increase our purchases of goods and services by an amount equal to the output of over 3 million workers to absorb the increase in the labor force, as well as the displacement effect of rising productivity. The answer to such a burden is economic growth—a 5-percent expansion of the Nation's total output and consumption of goods and services, equal to the combined percentage increases in productivity and labor force.

It was substantial economic growth of that approximate magnitude—achieved through expanding markets—that gave us high levels of employment in much of the post-World War II period. But in 1949 and in 1953–54, we saw how easily our economy can be shoved off balance—when markets fail to expand fast enough to absorb the rising output of an increasingly efficient economy.

These problems of attempting to maintain high levels of employment in the recent past will probably appear small by comparison with those that will demand our attention in the period ahead. One of the great challenges of automation is that it continues present difficulties in much more serious form.

THE SPREAD OF AUTOMATION WILL ACCELERATE

There is sufficient evidence to indicate that automation will be spreading widely through the economy in the coming decade. Competition and the drive for reduced production costs are compelling the introduction of automated equipment. The Journal of Commerce of September 7, 1955, reported that a survey of 20 machine-tool companies at the national machine tool show "disclosed the belief that automation will probably make almost twice as much progress in the next 5 years as it has in the past 10."

"Demonstrated advances in productivity are amazing," is the way M. A. Hollengreen, president of the Machine Tool Builders' Association, put it to the Journal of Commerce reporter. "In case after case, new machines will do a job in a third, a tenth, or even a fifteenth of the time formerly required. Advances in machine tools have never been as rapid as they have been in the past 5 years, and most members of the industry expect the pace to be stepped up considerably in the next half decade."

Productivity is already increasing at a faster pace than in the long-run past. In commenting on recent productivity increases in manufacturing, the August 1955 issue of the Federal Reserve Bulletin states that "output per man-hour has risen somewhat more rapidly over the past 2 years of recession and recovery than the average postwar rate of abut 4 percent a year."

In other words, man-hour output in manufacturing industries, which had been rising at an average annual arte of about 3 percent in the long-run past before World War II, rose to an average yearly rate of approximately 4 percent after the war and to somewhat more than 4 percent in the past 2 years.

As a result of the sharp productivity increases of the past 2 years, employment has lagged considerably behind the improvements in general economic conditions. This is particularly true in manufacturing. In September 1955, there were 600,000 fewer wage and salary workers employed in manufacturing industries than in September 1953 (17.5 million 2 years ago in September 1953, by comparison with 16.9 million in September 1955).

Automation—in addition to the more conventional improvements in machines and work flow—will be increasing the rate of the national economy's rising man-hour output still further. Instead of average annual productivity increases of some 3 to 4 percent, the annual rate of rising man-hour output in the national economy may reach 5 to 6 percent or more.

With a civilian labor force of 70 million, 5 to 6 percent annual increases in the economy's man-hour output would make it necessary to add about 3½ million new job opportunities each year, merely to absorb the possible displacement effect of rising productivity. Another way of stating it is that annual productivity increases of 5 to 6 percent in the coming decade will be capable of displacing about 3½ million or more employees each year, if the national economy fails to expand, along with the rapid improvements in productive efficiency.

LABOR FORCE GROWTH EXPECTED TO ACCELERATE

The problem grows still greater when we consider that the labor force will be increasing at an accelerating rate in the period ahead. And the accelerating growth of the labor force will require the addition of yet more new job opportunities each year, if high levels of employment are to be maintained.

The average annual growth of the civilian labor force at present is some 700,000 to 800,000, according to Government estimates. In 2 or 3 years, the expansion of the labor force will be accelerating—when those who were born since 1939 start looking for jobs (after taking account of probable increases in both school attendance of youngsters and retirement of the aged). The size of the labor force, according to Census Bureau estimates, will be expanding at a rising rate in the coming 10 years, at the same time when automation and other technological changes will probably be pushing productivity increases above the rates of the recent past.

Labor force growth

Period	Average annual increase	
	Number	Percent
1929-30	732,000	1.6
1930-40	609,000	1.2
1940-50	878,000	1.5
1950-55	698,000	1.1
1955-60	866,000	1.2
1960-65	1,172,000	1.6

Source: Current Population Reports, Bureau of the Census, Series P-50, No. 42, Dec. 10, 1952.

The civilian labor force, which has been growing at an average anual rate of about 1 percent in recent years, will probably be rising at annual rates of 1.2 to 1.6 percent in the coming decade. The accelerating growth of the labor force in the years ahead will probably necessitate the creation of some 800,000 to 1,250,000 new job opportunities annually, if high levels of employment are to be maintained. And this requirement is in addition to the necessity of the economy to prevent the disemployment each year of some 3½ million or more workers, when productivity rises 5 to 6 percent annually.

There is a possibility, therefore, that in the years ahead, the national economy will have to provide about 4½ million or more new job opportunities each year to absorb both the increases in the labor force and the displacement effect of rising productivity. To do so, the national economy's markets will have to expand more rapidly than in the recent past, when an average yearly 4- to 5-percent rise of the Nation's total output was generally sufficient.

With the labor force growing 1.2 to 1.6 percent a year in the coming decade, and man-hour output possibly increasing some 5 to 6 percent or more each year, the economy's output of goods and services may have to expand by some 6 to 7 percent or more annually, if high levels of employment are to be maintained.

EXPANDING ELECTRONICS INDUSTRY WILL NOT TAKE UP SLACK

There are those who tell us that this problem should be of no concern to us. An expanding electronics industry, they tell us, will automatically absorb workers who may be displaced from factory and office employment.

It is true that the electronics and machine-tool industries that produce automation equipment are expanding. But productivity in these industries is rising rapidly, with the introduction of labor-saving devices, new materials and automated equipment. These industries, too, are being automated.

A Department of Labor study states:

"Electronics output in 1952 was 275 percent higher than in 1947 but was produced only by 40 percent more workers. * * *

"Output per man-hour (in the electronics industry) may rise even faster during the next few years as a result of improvements in manufacturing techniques. * * * These trends toward 'automation' may result in the greatest reduction in unit man-hours in the industry's history during the next few years."

General Mills, Inc., the breakfast-food producer, for example, has announced that it has put on the market a fully automatic machine for the production of electronic equipment. Called Autofab, this new machine, it is said, will assemble, in a little over a minute, the same number of multiple-part electronic units that now takes one worker a full day to assemble. It requires only two workers and a supervisor, and has a capacity of more than 200,000 assembles a month, operating 40 hours a week.

I do not believe that we can complacently put our faith in the expanding automation-equipment industries to provide the large number of required job opportunities to maintain high levels of employment in the coming transition decade. Nor do I believe that the transition period to the era of the new technology will be accompanied by rapid and large-scale job-producing secondary investment—sufficient to be an adequate shock absorber. There is no assurance whatsoever—and there can be none—of automatic and immediate adjustments to the widespread introduction of automation.

Automation is a new technology with the possibility of economywide displacement effects; its major requirements are equipment and power from industries whose productivity is rising at sharp rates. The new technology, for that reason, cannot be compared to a new product, such as the automobile whose widespread introduction was, of necessity, accompanied by secondary investment in road construction, oil, rubber, steel, and glass.

PRODUCTIVITY OF CAPITAL ALSO RISING

Another factor that must be taken into consideration is that the productivity of capital is rising along with the productivity of labor. In some of the illustrations of automation I have given here today, it is noted that while the automatic machines cost more than those they replace, the increase in cost is less than the increase in productivity. That is to say, the investment per unit of production is actually less than that of the replaced machines.

This is in line with a long-term trend. Recent studies published by the National Bureau of Economic Research, show a fairly steady rise in the productivity of capital investment ever since World War I.

The rising productivity of capital, as well as of labor, makes it more important than ever that consumer markets expand rapidly.

There are those who try to tell us that there is no cause for concern, because increased productivity will automatically result in lower prices. The fallacy of this view is that automation finds its major field in the "administered price" industries, such as the automobile industry, where lower costs more often lead to higher profits than to reduced prices. For example, the Ford Motor Co. has announced that it expects to make a record profit this year. Yet rather than pass a share of that profit along to consumers in the form of lower prices, Ford has actually announced price increases on its 1956 models.

Then, there are the optimists in the sales departments and the advertising agencies who seem, quite honestly, to believe that we can sell anything we can produce if business will just put enough high pressure behind its advertising and selling campaigns. They seem to think that consumer purchasing power will be created automatically.

Only a little thought on the subject should be enough to convince anyone that consumer purchasing power will not be raised automatically. It will not be raised unless the benefits of increased productivity are passed along to the mass market of consumers through such measures as increased wages, reduced prices, and increased expenditures by Government in such fields as education and housing, as well as improved Government programs in such areas as social security and health. Increases in consumer purchasing power will arise, not from reliance on nonexistent automatic forces, but from the effort of private groups and Government.

RAPID GROWTH OF CONSUMER MARKETS IS ESSENTIAL

I do not believe that people who seek out untenable reasons for complacency about the potential problems posed by automation are serving any socially useful purpose. Neither do I believe that one need be unduly pessimistic. I am firmly convinced that our economy can adjust to the challenge of automation, if we use our foresight and the combined wisdom of private groups and Government. It is wise social policies by private and public groups that are called for, rather than either smugness or pessimism.

As I have already indicated, one major and rather obvious requirement for an orderly economic adjustment to the new technology is the continuing rapid growth of consumer markets, along with the economy's ability to produce a rising volume of goods and services. In the coming decade of transition to the widespread use of automation, emphasis will have to be placed—even more so than in recent years—on the need for consumer markets to grow rapidly.

A basic cause of the depression of the 1930's was our inability to realize during the 1920's that while increasing productivity creates the possibility of expanding production, it must be accompanied by rising purchasing power so that consumers can buy the additional goods and services which can be produced.

Increased man-hour output without growing markets is a formula for depression. Without customers for the mounting output that will be made possible by the widespread use of automation, mass unemployment will be inevitable.

I can asure you that organized labor will in the future, as in the past, do all in its power to maintain an expanding mass consumption base for the national economy. But the consumer purchasing power needs of the coming decade will require, to a greater extent than in the past, that business accept collective bargaining and the right of workers to continuing improvements of their living conditions.

Rapidly growing consumer markets, however, require more than price reductions and union gains in wages, guaranteed wage plans and fringe benefits. They likewise require Federal, State, and local tax structures that will provide expanding consumer purchasing power, especially among the millions of low- and middle-income families. They require, too, an adequate unemployment compensation system for unemployed workers, and an improved social-security system for retired workers, and a generally liberal monetary policy that will encourage small business, farmers, and consumers to expand their investments in plant, equipment, homes, and consumer durables.

THE MINIMUM WAGE SHOULD BE INCREASED TO AN ADEQUATE LEVEL

The needed rapid growth of consumer markets will require further increases in the statutory minimum wage. According to the staff report, prepared for the Senate Labor Committee, which investigated the minimum wage, the increase from 75 cents to $1, which comes into effect next year, will not be sufficient to take into account the combined effect of the increase in the cost of living and increased productivity since the beginning of 1950, when the 75-cent minimum became law.

In a period of sharply rising productivity, it is a national disgrace that a country as wealthy as ours should still have a considerable number of workers earning no more than a bare subsistence. The $1-an-hour legal minimum wage, effective March 1, 1956, should be revised to $1.25 without delay, and coverage under the law should be extended. As a matter of public policy, we should adopt a program designed to increase statutory minimum wage levels, substantially faster than increases in productivity, until they shall have reached a point where we need no longer be ashamed of them.

LENGTH OF THE WORKWEEK MUST BE REDUCED

An important step toward minimizing potential social dislocations during the coming decade of transition to the new technology would be the reduction in length of the workweek.

In the past the rise in man-hour output has made it possible to increase both leisure and total output. Rising productivity at present—and the more rapid increases expected in the coming decade—makes possible further increases in leisure.

The reduction of the workweek to 35 or 30 hours in the coming decade can be an important shock absorber during the transition to the widespread use of automation. It can both reduce the impact of sharp rises in output and increase the manpower requirements in industry and commerce.

The past reduction of the workweek to 40 hours, and the prevalence of paid vacations and holidays, have brought a share of the fruits of industrial progress to wage and salary earners in the form of increased leisure. These proud achievements of organized labor and the New Deal have contributed to the growing importance of leisure-related activities—such as educational, recreational and cultural facilities, do-it-yourself, gardening tools, sports equipment, motels, and vacation resorts.

The further reduction in the length of the workweek, below 40 hours, in the years ahead will probably result in a stimulus for additional leisure-related activities—additional education, museums, libraries, parks, sports, and resort centers.

The 30- or 35-hour week, the 2½- or 3-day weekend, extended vacations, early retirement for older workers, and increased schooling for young people—these are some of the possibilities that arise out of the anticipated rapid increases in productivity during the coming decade. But we will not achieve these possibilities without planning for them and working for them.

In many industries we will be able to achieve a further reduction in the workweek through effective trade-union organization and collective bargaining. But the increased leisure which automation makes possible will not be enjoyed by all groups of Americans, except through legislation to shorten the statutory workweek under Federal and State laws. Here is an area in which a continuing study of industrial conditions and the effect of automation on employment can be particularly valuable as the basis for recommendation to Congress for legislative action.

In the same way, we will not achieve early retirement under the Social Security Act, or increased vocational training, or improved educational opportunities for young people without Government guidance and action.

One of the fruits of automation, which we should welcome, is the opportunity it gives us to meet the present and growing social deficits in health, housing, schools, highways, natural resources, and other public services. Through increased productivity, our economy can meet the cost of these long-delayed measures, without strain—and their achievement will help, by creating new jobs, to ease any necessary adjustments in employment.

But I hope we will not wait until unemployment has become a serious problem before we make a start. Mililons of new homes, at least a million new hospital beds, hundreds of thousands of added school classrooms will be required within the next few years, simply to meet the needs of a growing population for adequate housing, health and educational facilities.

The rapid productivity increases that automation makes possible should enable us to devote increasing attention to social welfare and public services. Such activities should be viewed as a means of strengthening the fabric of our society, rather than as mere antirecession devices.

SMALL BUSINESS REQUIRES AID

The maintenance of high levels of employment nationally is the major requirement to reduce the size and nature of the possible problems posed by automation. Nevertheless, the dynamic changes of the transition period—even with high levels of employment generally—will probably be felt by some groups of workers and businesses. For them the impact will be harsh, and some forethought by private groups and Government must be given to devising means of assistance.

Many small business firms, as well as workers, may find themselves in distress during the period of transition to the new technology. In some industries, automation equipment may be so expensive—and the required output so large—as to make its use prohibitive by small or medium-sized firms.

Small business has been hard pressed in the past 2 years. Business failures rose sharply in 1954. They remain high now, despite the general improvement in economic conditions. Last June there were 914 business failures by comparison with 965 in June 1954, 817 in June 1953, and 671 in June 1952.

Small and medium-sized business has not shared in the recent prosperity of the giant corporations.

The quarterly financial reports on United States manufacturing corporations, issued jointly by the Federal Trade Commission and the Securities and Exchange Commission, show that between the first quarter of 1953 and the first quarter of 1955, manufacturing companies, with assets of $100 million or more, increased their sales by $2.2 billion; their profits before taxes went up by $450 million, and their profits after taxes by $591 million.

In the same period, the sales of all other manufacturing corporations declined by $2.5 billion, their profits before taxes fell by $578 million, and their profits after taxes were lower by $102 million.

These figures have the closest bearing on the economic questions posed by automation. For the most part, it is the large companies that will be in the best financial position to scrap old equipment and old plants, and replace them with new automated machines and automated plants, thus increasing still more the margin of efficiency which they enjoy over their smaller competitors.

It is possible that relatively low-priced electronic computers will be available for smaller firms. It is also possible that some types of multiple-purpose automated equipment will be available for medium-sized plants whose products are mixed. But in industries where a great volume of identical products are made—as in the automobile industry—the required output for profitable operations may be so great, and the cost of the equipment may be so high, as to make it difficult, if not impossible, for small firms to purchase automated machines.

Government policy should be aimed at assisting small business firms to maintain their existence. A generally liberal credit policy—with low interest rates—is an essential part of such programs to enable small businesses to obtain funds for investment in expensive automatic machinery. Long-term Government loans, at low interest rates, for industrial and commercial expansion, should be made available to small- and medium-sized firms. Government procurement policies should aim at getting work on Government contracts to smaller businesses. The antitrust division of the Justice Department should be instructed to be more vigilant than it has been in the recent past in the effort to eliminate monopolistic practices in industry.

Automation may bring with it the danger that big firms will grow even bigger, while small- and medium-sized competitors are squeezed against the wall. The danger must be minimized by Government policies and actions to assist small business and prevent trends toward monopoly.

SUGGESTED POLICIES

Automation has been hailed as the "second industrial revolution." But no radical change in technology can take place without parallel changes in the economic structure.

It is within our power to see to it that these economic and social changes take place in an orderly and evolutionary manner—toward improved standards of living and social welfare, an extension of leisure and new horizons of individual opportunities for educational and cultural achievements. Such evolutionary changes in the coming decade will require forethought, planning, and guidance. If we permit the new technology to follow its own blind course, directed only by the selfish interests of those who would utilize it for their own immediate profit, our free society may be subjected to dangerous disruption in a world beset by international tensions.

We cannot permit any weakening of our national strength nor any undermining of our social fabric. The Communists are only too willing to assist in such an endeavor. We should take advantage of the rising productivity that automation makes possible to increase our national strength and improve living standards at the same time.

High levels of employment and rapid economic growth must be achieved in the period ahead. But those goals can be attained only through growing markets that will expand rapidly, along with the economy's rising productivity. A positive Government effort is required to provide the expanding markets that are the basis for economic growth.

Organized labor is doing its part, through collective bargaining for higher wages, extended vacations and holidays, guaranteed wage plans, improved pension and health-welfare plans. There is no need to defend these social gains won by unions for millions of working people; they stand on their own merits, and rising profits, generally, indicate that business has been able to pay for them. But the power of big corporations to administer prices has tended to dilute some of the benefits of these improvements.

A national approach is needed to help make certain that the benefits of automation will be shared among all groups in the population. A congressional inquiry into the price policies of giant corporations, for example, is long overdue—to place the spotlight of public attention on the failure of the dominant corporations to pass on to consumers the benefits of rising productivity.

There is need, too, for a more equitable distribution of the tax burden, an adequate unemployment compensation system, improved social-security benefits, a higher legal minimum wage and reduced legal workweek, protection of farm income, improved educational facilities, financial aid to students, and an extended program of hospital and road construction, and natural resources and development.

CONTINUED STUDY IS ESSENTIAL

We in the CIO do not pretend to have the answers to all the problems posed by automation. We are quite sure, in fact, that no one can have all the anwsers at present. Not nearly enough is known yet about the current achievements of automation, the planned progress of automation, or the precise impact that automation will have on productivity, on employment, and on the national economy.

No one in industry or Government has yet gathered together in one place enough information about what is happening in the field of automation to have the full story. Individual companies know what they are planning or already have done, and corporations manufacturing automation equipment may know what their customers are doing, but there is still the job of putting this knowledge together coherently.

I hope that in these hearings the subcommittee will ask representatives of various corporations, who come before it, to answer specific questions about what their companies have done and intend to do in the way of introducing automation, and the impact of automated equipment on manpower requirements.

I would urge that a continuing study of the social and economic impact of the new technology be made, either by members of the staff of this subcommittee, or by some Government agency to which the subcommittee might recommend that the task be entrusted.

Through these hearings and a continuing study, we should find out just how much displacement of manpower in industry has already resulted from automation, to what extent the displaced workers have been absorbed into other jobs with their own employer or with some other employer, the impact of such displacement on older workers, how many displaced workers have been able to find other jobs, how many are unemployed, how many displaced workers have retired from the labor market, and how adequate are the incomes of those who have retired. We should find out to what extent displaced workers tend to move into jobs like their old ones, and to what extent they are forced to accept lower-paid jobs requiring less skill.

From these hearings and future studies, we should find out to what extent the introduction of automation, by firms which are able to expand their share of the market, has resulted in the disemployment of workers in other companies that have not been able to make the investment in automated equipment. For example, it has been said of the auto industry, that automation in Detroit has resuled in unemployment in South Bend. Some employers may be able to tell this committee that they have been able to maintain, or even increase, their employment in spite of automation. But that is only half the answer, if expansion on the part of such employers has resulted in unemployment in other plants and in other communities.

A thorough study should be made of the industrial movements which may be anticipated over the next several years—the industries and geographical areas most likely to be affected, and the problems that will probably be created both for workers and for their families, and for the affected community.

Particular attention should be concentrated on the prospective rate of productivity increases, as a result of automation and other technological advances. This information is essential if we are to have an idea of the required increases in consumer purchasing power and the possibilities for the rapid reduction in the length of the workweek. It is likewise essential if we are to be able to plan private and public policies intelligently for continued economic growth and the maintenance of high levels of employment.

STUDIES MUST LEAD TO ACTION

The results of these hearings and ensuing studies should lead to positive recommendations from this subcommittee to the Congress. Such recommendations should cover the problems of displaced workers, industry migrations, stranded communities, small business, and education requirements. Above all, such recommendations should promote national economic policies, designed to expand consumer-purchasing power, with sufficient speed, so that we shall be able to buy and consume the vast flood of goods and services made available by automation. Such policy recommendations should be aimed at taking full advantage of the opportunities presented by rapid productivity increases—to improve Federal, State, and local facilities in health, housing, education, natural resources, and other fields of public activity.

We must do all in our power to make sure that the potential abundance of the new technology will be used with social wisdom to improve standards of living and welfare, and to provide increased leisure, for all Americans.

These are great tasks. In the years that lie immediately ahead, we shall have to undertake these tasks, because the new technology confronts us with a tremendous challenge. If we refuse to accept that challenge, if we fail to solve the problems that will probably crowd upon us, we may be forced to undergo shattering economic dislocations that could threaten our whole economy and our free society.

If we accept the challenge of the new technology, if we use foresight and act wisely and vigorously, we can help to usher in an age of abundance and freedom, the like of which the world has never known.

APPENDIX TO TESTIMONY OF WALTER P. REUTHER, PRESIDENT OF CONGRESS OF INDUSTRIAL ORGANIZATIONS

SEVERAL RECENT EXAMPLES OF AUTOMATION

Industry and technical journals, as well as newspapers and magazines, contain frequeint stories of the advance of the new technology. The following is a mere handful of such recent examples of the spreading development and utilization of automation:

[From the New York Times, March 28, 1955]

AUTOMATIC MILLING MACHINE TO CUT LEAD-TIME DRASTICALLY

The Air Force announced the award of a $1,128,000 contract to the Convair Division of the General Dynamics Corp. on March 27, 1955, to develop the aircraft industry's first electronically controlled milling machine. This automatic machine will be controlled by an electronic computer and will be based on the development of the automatic milling machine at MIT. It will be capable of producing prototype parts, as well as production parts. Convair engineers estimate that the machine will save as much as 85 percent of the lead time on some parts and about 15 percent of the lead time on very complex parts.

[From the American Machinist, August 1, 1955, p. 106]

TURRET LATHE CONTROLLED FROM PUNCHED TAPE CAN BE RUN BY UNSKILLED OPERATOR

Electronic control by means of a punched tape permits a Jones & Lamson Machine Co. turret lathe to be used on short-run jobs, thus opening new fields of application, and allows an unskilled operator to replace a highly skilled lathe operator.

"Setup, heretofore, required a skilled operator or a setup man," says the American Machinist. "Now the setup is planned by a methods engineer or 'programer' and the tape is punched accordingly by a clerk—both in the office. The tape is delivered to the machine with the shop order and operation sheet or tool scheme. An unskilled operator can mount the numbered, 'plug-in,' preset tools according to the chart and can place the tape in the machine director. As simply as this, the machine is ready to produce pieces.

"Upon completion of the run, the tape can be stored in a filing-cabinet drawer for future uses, such as new orders, to replace scrap, or for spare parts. Standard tapes can be prepared for routine operations, frequently repeated, and kept on hand to expedite simple jobs or to simplify preparation of complicated setups."

The machine does not produce contours in the manner of the MIT milling machine, but provides rectilinear motions with precise control at the end points. In addition the tape controls:

Choice of 16 spindle speeds, at any time and without stopping the spindle;
Indexing six-position turret to any face at any time;
Indexing four-position turret on cross-slide to any face at any time;
Operation of hydraulic-powered collet chuck and bar feed;
On or off control of coolant;
Closing and opening of hood;
Resetting of tape to repeat cycle.

[From Instruments and Automation, January 1955, p. 111]

TRANSFER MACHINE FOR AXLE HOUSINGS INCREASES PRODUCTIVITY 3.6 TIMES WITH LOWER INVESTMENT

A transfer machine produced by the Cross Co. performs the operations of boring, facing, drilling, chamfering, and tapering on axle housings. When the machine was installed in 1952 it replaced 5 separate machines which originally cost a total of $270,000, but which would cost $540,000 to replace today. The cost of the transfer machine was only $318,000.

On the old machines, 3 men turned out 10 pieces per hour. On the new machine, 2 men turn out 24 pieces per hour. Productivity is 3.6 times as great per man-hour.

[From American Machine & Foundry Co. leaflet]

AUTOMATIC BOWLING ALLEY PINSPOTTER

An automatic pinspotter developed by AMF Pinspotters, Inc., a subsidiary of American Machine & Foundry Co., replaces the pinboy in bowling alleys with a completely automatic operation. As pins are knocked down, they are picked up on an endless belt in the pit and placed in the machine for resetting, while the ball is automatically returneed to the bowler. A lighted indicator shows how many balls have been used in each frame and what pins are still standing. Standing pins are lifted after each ball and then replaced, but if a pin has been knocked off its spot and left standing, the machine replaces it exactly in the off-spot position from which it was lifted. The machine operates with two sets of pins, so that in case of a strike or a foul the second set can be put in place without delay while the first set is being picked up and returned to the pinsetting mechanism.

MACHINE WITH ELECTRONIC MEMORY AUTOMATICALLY BALANCES CRANKSHAFTS

A machine developed by the Tinius Olsen Co. uses an electronic memory which enables it to balance crankshafts automatically to within one-half ounce-inch of perfect dynamic balance.

A scanning screen receives impulses which are made by scanning the revolving crankshaft. If the crankshaft is out of balance, the machine determines how much it is out of balance, and where the imbalance is located. An electronic memory unit retains all the information transmitted to it while the crankshaft was previously revolved. Then, with the crankshaft held stationary, the machine automatically sets into action drills which remove the exact amounts of metal required to establish perfect balance in the crankshaft.

[From the Wall Street Journal, June 17, 1955]

BANK COMPUTER CALCULATES INTEREST ON 290,000 SAVINGS ACCOUNTS IN 33 HOURS

The Western Saving Fund Society, Philadelphia's second largest mutual savings bank, has installed computer equipment that will make year-end interest computations on the bank's 290,000 savings accounts in 33 hours—a job that used to take "a large force" of workers 3 weeks.

[From Business Week, June 18, 1955]

AUTOMATIC ASSEMBLY OF RADAR SETS

An automatic assembly machine for assembling military radar sets has been produced by General Mills, Inc., for International Business Machines Corp.

With a single machine, components are fitted onto a chassis automatically. The machine can produce about 200,000 assemblies a month. In 1 minute it produces 20 assemblies, as many as a fairly fast hand assembly line could produce in 20 minutes.

Business Week states the same principle is now being introduced in production of television sets. It claims that through a combination of automatic assembly, etched wiring and dip soldering, by 1956 a production line with about 40 people will be able to produce as much as a line of 125 people doing the same operations by hand.

[From the Wall Street Journal, April 1955]

ELECTRONIC BRAINS TO "RUN" WAREHOUSE OPERATIONS

Super Valu Stores, Inc., of Minneapolis, which supplies 560 stores in 2 chains of independents, has ordered 2 medium-sized electronic "brains" from Remington Rand for two of its warehouses. They will—

Turn out a daily inventory report in 30 minutes—a job now taking 1 person 40 hours;

Take a complete bookkeeping inventory in 30 minutes, against 240 man-hours now required;

Notify buyers automatically when warehouse stocks of any product have run out;

Type out a purchase order automatically when stocks of any item reach a minimum reordering level;

Tell warehouse personnel exactly where they can find any product, and how much of it is there;

Carry out billing, sales analysis and general accounting functions.

The machine is described by its developers as a "high-speed idiot," but if it makes an error it is able to discover the slip itself through a series of self-checking devices.

The "brains" are expected to be in operation in about 18 months.

[From the New York Times, June 16, 1955]

AUTOMATIC "SKIN MILL" CUTS MACHINING ON AIRCRAFT WINGS FROM 60 HOURS TO 3.25 HOURS

Simmons Machine Tool Corp., Albany, has produced a 225-ton automatic "skin mill" to be used in manufacturing one-piece wing panels for the F-11 super-sabre jet at the North American Aviation Co. plant in Los Angeles.

Electronically and hydraulically controlled, the 225-ton machine will sculpture the aircraft wings in a fraction of the time required by conventional machining methods. Simmons officials say it can accomplish in 3¼ hours a complex machining operation that formerly took 60 hours. It can turn out two wing panels simultaneously, its carbide-tipped cutters making longitudinal, transverse, and diagonal channels according to intricate patterns.

Simmons says the machine is one of the first examples of automation in manufacturing large, strong, integrally stiffened aircraft wings. It has 2 consoles with banks of pushbutton stations comprising 60 individual controls. Its cutting tools can remove as much as 250 cubic inches of metal per minute.

[From the Wall Street Journal, October 6, 1955]

SANTA FE ROAD TO GET ELECTRONIC SYSTEM TO HANDLE RESERVATIONS

Teleregister Corp. of Stamford, Conn., will install equipment on the Atchison, Topeka & Santa Fe Railway in the first steps toward a coast-to-coast electronics network for handling of passenger accommodations. The Santa Fe equipment will be integrated with similar equipment to be intalled on the New York Central and New York, New Haven & Hartford Railroads.

The electronic equipment will keep track, automatically, of all reserved accommodations. It was said that a traveler will be able to get confirmation of his reservation in little more than the time it takes for him to light a cigarette.

The target date for coordinated installation of the Teleregister equipment is the middle of 1956.

The CHAIRMAN. If you desire, you can speak impromptu, extemporaneously, or otherwise, just as you choose.

Mr. REUTHER. Thank you.

I would like to elaborate extemporaneously on the problem as we see it.

We believe that we are really standing on the threshold of a completely revolutionary change in the scientific and technological developments that we have experienced. We believe that in addition to the problem of automation, which is the general term used to define the new technology, we also face the possibilities, the promise and the problems that will flow from the peacetime use of atomic energy and ultimately the use of solar energy.

We believe that the challenge is great, but that the opportunity is even greater. As we in the labor movement visualize this problem, we believe that this is the first time in the history of human civilization that we are achieving the technology, the tools of production, that will enable us as free people to master our physical environment. For centuries and centuries and centuries people have been struggling to find a way to satisfy their basic economic and material needs, to get enough food in their empty bellies, to get enough warm clothing on their naked backs, and to provide decent shelter. For centuries they have struggled with the economics of scarcity; now we are entering that period of human history when the tools of abundance made possible by developing science and technology make it possible for mankind to meet basic economic and material needs.

And, having satisfied these needs, we can devote more time, energy, and resources to facilitating man's growth as a social being, as a cultural and spiritual being. This means that the possibility of adding value to human civilization and the dignity of the individual now is greater than ever before, provided we have the good sense and the sense of moral and social responsibility to use these new-found tools in the interest of all of the people.

So we welcome the development of science and technology. We are very happy that industry is able to have more efficient tools, but we insist that we find a way to gear the efficiency and the greater productivity and greater abundance to the basic needs of all of the people.

I believe that this developing technology is going to put in the hands of freemen the tools with which they can prove that the Communists are wrong. Karl Marx, many years ago, attempted to analyze history. He attempted to try to develop a description of the underlying motivating forces that made people and nations move, and so he wrote the book that everyone knows about, Das Kapital, but he was wrong. He was wrong because historically he analyzed the world in terms of a struggle between people and nations and groups to divide up economic scarcity. One nation was well fed because another nation was hungry. One citizen had many of the good things of life because some other citizen was denied the good things of life, but Marx was wrong because he did not and perhaps could not have visualized the unlimited possibilities of cooperating in the creation and sharing of abundance.

Adam Smith was wrong, because he also could not understand the tremendous possibilities of abundance.

And so here we are, standing on the threshold of a development of science and technology that will enable us to solve the problems that have plagued the human family for these many thousands of years. And the great challenge is not "are the engineers going to develop the tools?" because they are. The great challenge is, are we as a free people going to be equal to that challenge, by demonstrating that we know how to use these tools for human betterment, for elevating living standards, for giving people more security, and, in the atmosphere of security, facilitating the growth of the human spirit and the dignity of man.

That is really the great challenge. We have said many, many times that the struggle in the world between our way of life, between the forces of freedom and the forces of tyranny, on the other hand, is more than just a struggle for geography; that essentially it is a struggle for men's minds and their hearts and their loyalties.

We believe that that struggle will not be won with guns, no matter how big or how powerful an H-bomb may be developed. In the final analysis what we do with our economy, what we do in gearing the abundance open to us to the needs and the hopes and aspirations of people, how we demonstrate the capacity to deal with practical human day-to-day problems, is going to win for us in the struggle for men's minds and their hearts and their loyalties, not in the areas of developing the H-bomb. The H-bomb is necessary, but it is the negative aspect of this struggle. It is the holding action. We are going to win on the positive end of this struggle, by demonstrating that we as a free people know how to mobilize our productive resources and to gear the abundance now possible to the needs of the people.

The Communists, of course, in their propaganda to try to win over people in the uncommitted portions of the world, have always promised economic security; when you are hungry—and most of the people of the uncommitted world are hungry—when you are hungry enough and desperate enough you will take most anything, as the way out.

The Communists are hoping to win over people in this world struggle by offering them the promises of economic security, despite the fact that in every country in the world where the Communists have seized power they have as yet failed to deliver on that promise. Even if they do deliver, the price is too great, because in order to get bread in your stomach you have got to put your soul in chains; in other words, you have got to trade your political and spiritual freedom for a loaf of bread.

We face the practical problem of having to demonstrate, not in the ivory academic towers, not in a general way, but in a specific and tangible way, that you can have both bread and freedom; that you can take care of your economic and material needs, and that, having done that, you can enjoy a greater measure of political and spiritual freedom.

Now, how do we go about doing that? That is really the great problem. We believe that the Geneva Conference marked a turning point in the cold war, in the struggle between the forces of freedom and the forces of tyranny, and we believe that we need to understand what is transpiring. The Russians, in my opinion, have made no change in their long-range struggle for world domination. They have made only a tactical shift, in the way they intend to pursue their struggle for world domination.

If you will look at the situation in Europe—and I have just come back from Europe and the Middle East, where I had a chance to talk to labor leaders, government leaders, to industry leaders, to educational leaders, and to people connected with the various faiths—I have a feeling that the Russians, in their new look, are attempting to lull the free world to sleep, and they are attempting to make it look as though the threat, that was real and great was now being diminished. And because people may think the threat is being diminished, they hope to destroy, or to weaken, the common denominators that hold the free world together. What are those common denominators? Essentially they are the common denominators of fear and hatred. They think if they can taper off the negative forces of fear and hatred that hold us together that we will go back to business as usual, to life as usual, and that the free world alliance will begin to disintegrate. What we need to understand is that the Communists will succeed unless we develop a new set of common denominators, built around positive human values, as the cement that holds together the free world alliance.

I believe that in looking at the problems of automation you have got to evaluate them, not only in terms of the needs of America, not only in terms of our own domestic economic problems, but that you have got to look at automation and the new tools of production in terms of the total struggle that free men must wage against the forces of tyranny in the world.

We believe that America must maintain a strong military posture, because none of the underlying factors that made for a strong military posture last year, or 2 years ago, have changed; but, while maintaining a strong military posture, we must take the offensive on the economic and social fronts in the struggle against poverty and hunger and human desperation in the world. It is on that front that freedom must win over tyranny.

Some recent changes should indicate to us what the Russians are about in their new look. Last week they offered countries in the Middle East arms; a week later they offered them unlimited technical assistance—in any phase of technical development that these countries asked assistance in. That means that the Russians are going to work harder and harder and harder on the subversion of people by economic assistance programs, by technical assistance programs. And that means that America, the strongest of the free nations of the world, needs to do more in this area. And automation and the new sciences that are developing provide us the tools with which to do this job.

Our great dilemma in America, Mr. Chairman, as we understand it, is the fact that we have made much more progress in the physical sciences than we have made in the human and social sciences. We know a great deal more about working with machines than we know about how to work with people. One of the problems that we have got to work on, as this whole technological development moves forward, at ever accelerated speed, is the finer way to develop comparable know-how in the human and social sciences, to match the know-how that we have in the physical sciences.

What we need to do is to match our scientific, technical, and production know-how with comparable human and social and moral know-how. The production process is not the end. It is the means to the end. The end is the enrichment of human life. The end is to meet man's basic needs, within the framework of an expanding intellectual, political, and spiritual freedom. We can do these things only if we learn to match our technology in the physical sciences with comparable technology in the field of sociology, in the field of politics, in the field of human relations.

It is in that spirit that we approach the problems of automation. We welcome automation.

There has been a great deal of propaganda. Even the Secretary of Commerce has misrepresented the position of American labor with respect to automation. He woud have you believe that we are opposed to automation. We are not. We welcome any development that will lighten the burden of human labor. We welcome any step forward that will make it possible for mankind to create greater economic wealth, with less human effort.

What we do insist upon, however, is that we find a way to gear this developing technology, this greater economic abundance, to the needs of all of the people.

We have said many times that really the measurement of the greatness of our society is not how much economic wealth we have, nor the size of our material resources, nor the level of our technological development; the real measurement of the worth of any free society is the ability of that free society to translate technical progress into human progress, into human happiness, into human dignity. So we welcome automation; but we say that unless we develop broad economic, and social policies, to insure that this new power is used responsibly in the economic and social and moral sense, then automation, instead of building a brave new world, can dig our economic graves.

It is because we raise these problems that people have attempted to say that we were opposed. We believe that we have got to look at this problem realistically, with honesty, and with courage. When you say there is a problem here it doesn't mean that you are opposed to automation. It merely means that you are trying to anticipate the problem so that we can meet it in advance.

The first industrial revolution created many serious problems. The economy was dislocated, hundreds of thousands of workers were turned on the streets to wander without homes, without hope. We believe that the second phase of the industrial revolution can bring about dislocation unless we plan to meet the problems it raises.

The other day, I am told, one of the vice presidents of the Ford Motor Co. came before your committee. I think he gave you a lot of very valuable information, but I take issue with one conclusion that he left with your committee when he said that automation is just an extension of the normal technological evolutionary process. I believe that is an understatement of what automation is. Automation is the second phase of the industrial revolution.

James Watt, when he developed the first simple and crude steam-powered machine, which was used in the textile industries of England, made the first step toward the substitution of mechanical power for human power—mechanical muscles replaced human muscles. We took that simple beginning and we developed our mass-production economy. But automation is not just an extension of that technological process. Automation makes a completely new development in the technological process because automation, in addition to substituting mechanical power for human power, begins to substitute mechanical judgment for human judgment—the machine begins to substitute the thinking process on a mechanical basis for the thinking process which heretofore was done exclusively by the human mind.

The machine has a memory in which you can store all sorts of complex information. With specific impulses you can bring that information out of the memory and with it begin to instruct the machine to do very complicated tasks.

This is why automation is not a normal extension of the technological process which was initiated at the beginning of the industrial revolution, but marks a second phase of the industrial revolution.

It means that because the machine now cannot only replace human power, but can replace human judgments, its impact will be much greater than the impact of the first phase of the industrial revolution.

I think it is dangerous wishful thinking to believe that the problems of automation will not be great and will not be complex and will not be challenging. If by wishful thinking you could brush these problems under the rug and forget about them, I should be very happy to join in that kind of wishful thinking. But you cannot brush them under the rug. You cannot look the other way. They are challenging. You have got to meet them. To the extent we face them with honesty and with courage, and with conviction, to that extent we as a free people will be able to find answers to these problems.

We got in trouble in 1929—not because the problems that we faced in 1929 were insurmountable. Every problem that we had in 1929, when the stock market crashed, and all of the problems of human suffering that followed those dark years of depression, were problems that were manmade; none of them was ordained by Almighty God. None of them were beyond man's ability to master. But people said we were on the high road of permanent prosperity; that only utopia lay ahead, and all that we had to do was to buy a couple of more shares of stock and ride the magic carpet to perpetual prosperity. And then the world came tumbling down around our ears.

All we are saying is that there are problems, and that we need to recognize that there are problems, and we need to deal with those problems realistically. If we do that, we can make the transition that this second phase of the industrial revolution will bring about; we can make it with a minimum of dislocation, with a minimum of hardship, with a minimum of heartbreaks, and we can all have more of the good things of life.

Now, if we got in trouble in 1929 because people tried to brush the problems under the rug, we will get into more serious trouble if people attempt to brush out of sight and mind the problems that automation and peacetime use of atomic energy—and some day solar power—will confront us with.

I think it is just this simple, Mr. Chairman: The economy that we had in 1929, compared to the economy that we have today, and will have tomorrow, and will have the year after tomorrow, was a model T economy, and we are now dealing with a high-octane, supersonic, jet economy. If we got in trouble driving the model T in high gear, it is just a matter of common horse sense that a smashup under modern conditions would be even more catastrophic, because we are moving at faster speeds. The faster we move, economically speaking, the more we need to think ahead and anticipate the problems.

If you are driving a car at 20 miles an hour, your mental process only has to move fast enough to think in terms of what is ahead at 20 miles an hour. A jet pilot, flying a supersonic jet at 600 miles an hour, is not thinking about what is happening where he is. He is always thinking about what is going to happen a minute from now, because in that minute he will travel a tremendous distance. What is true of a jet pilot is true of those people who are responsible for guiding a jet propelled economic machine. It is not good enough for us to think about today. We have got to anticipate the problems of tomorrow, because only if today we anticipate the problems of tomorrow can be begin to do today what is necessary to meet the problems of tomorrow.

So we have been trying to urge that today, Government, industry, and labor, agriculture—all of the free segments of our free economy—begin to recognize the problems and begin to work cooperatively in meeting these problems.

Now, basically what is our problem? Basically, our problem is the problem of maintaining a dynamic, expanding balance between our growing ability to create greater and greater economic wealth, reflected by our expanding productive power, and on the other hand, the ability to expand purchasing power in the hands of millions and millions of American families, so that we can maintain this dynamic expanding balance: Greater productive power, greater purchasing power, still greater productive power, still greater purchasing power, always achieving a dynamic expanding balance at higher and higher levels of economic achievement, ever higher economic plateaus. The answer to the problem of achieving this dynamic balance between greater productive power and greater purchasing power is the key to where the free American economy is going. And I believe it is the key to where freedom in the world is going. The basic needs of people are not static. Needs are largely a reflection of your ability to satisfy needs. What people had a hundred years ago will not meet our needs today. What we have today will not meet our economic needs tomorrow. You have got to measure how well we are satisfying people's needs, not by the standards of yesterday, but by the level of technology and by the tools that we have at our disposal in meeting these basic needs today and tomorrow.

We in the CIO have unlimited faith in the capacity of our free economy to meet these needs, but we believe we must be constantly vigilant, we have constantly to work on the problem. If we got in trouble in 1929 because there were powerful groups in America resisting the efforts needed to keep this dynamic balance between productive power and purchasing power, it would be dangerous and unrealistic to believe that those forces now are going to roll over and play dead. They are going to be in there, exerting the same pressures that they exerted in the pre-1929 period; unless those pressures are offset by a stronger counterpressure, then they will do the damage in the period ahead that they did in the period before 1929.

I would like very briefly to list some of the areas in which we think automation is going to develop and some of the problems. The range of automation is very broad. It has already had a tremendous impact in many segments of our economy. It has been applied to whole plants, to whole industries, it has been applied to a single machine.

Take the automated lathe, one simple example. A lathe now can be automated and can operate from 5 to 8 hours without the need of supervision. It will change the tools automatically when the old tool wears out. And before the tool completely wears out, the lathe keeps making periodic adjustments to allow for the normal wear in the tool, so that the part being machined will maintain the same precision as the first piece that the machine turned out.

Most people think of automation as something affecting just the auto industry, or basic metalworking industries, but we have seen a recent example where automation is being applied in the building industry, where the Cleveland Building Supply Co. has automated the mixing of cement. They have an electronic machine that can control the mixing apparatus and dump it into a truck and give you 1,500 different mixes, each with the exact amount of the various ingredients. Already it is being applied in the building industry.

Perhaps the most dramatic example of automation in the automotive industry is the Ford Motor Co.'s new engine plant, which you probably have heard a great deal about.

I have here some pictures and some charts of some of the types of machines that we have in the auto industry which I should be happy to leave with the chairman.

You have a situation where a rough casting comes out——

The CHAIRMAN. That is the Cleveland plant?

Mr. REUTHER. The Cleveland Ford engine plant, where a rough casting comes out of the foundry. (The foundry is automated, because the sand is dumped into huge hoppers and the other ingredients that go into manufacture of cores for the foundry and the manufacturing of the cores is all automated.) The rough casting comes into the machining operation. It is fed into the machine, and the first operation is to machine the top of the cylinder block and the bottom where the crankcase goes on. It takes 13 seconds to do that operation. It just goes "whoosh" and it is done. The rest of the operations are worked from those two machined surfaces. The automated lathe then bores the cylinder block. After the cylinder block is bored, the electric eye measures the block and, if it is not to the exact size required, an electric impulse goes to the brain of the machine, and the tool is adjusted, a new cut is taken, it comes back up, the electric eye measures it.

If it is the size, it goes to the next operation. That machine block comes out the other end in 14.6 minutes, without a human hand touching it.

Some years back, we made the first engine block in 24 hours, from a rough casting to the finished block. To machine a rough casting to the finished motor block in 24 hours was hailed as unprecedented technological achievement. Then we got it down to 9 hours; the old equipment in the Rouge Ford plant did it in 9 hours.

We jumped to 14.6 minutes. That is just the beginning, because they have drawings on the engineering drawing boards now that will do it in less time than 14.6 minutes.

When you go through the Ford engine plant—and I would urge strongly that you spend a couple of hours going through some of these plants—it is hard to find the workers. They are hidden behind huge electrical panels, on which there are red, green, and yellow lights. They sit there watching these lights. Every tool on every operation has a green light, a yellow light, and a red light, and when all of the green lights are on, it means that all the tools at each work station are operating up to standard. When a yellow light comes on, on tool No. 38, it means that the tool is still performing, but the tool is becoming fatigued, and that is a warning sign, so that the operator sitting there looking at these panels will know that he has to get a replacement tool for tool No. 38. He stands by at that position on the automated machine, and at the point the red light would kick on, on the board, he walks over—the machine automatically stops—he puts the new tool in the place of the tool that is worn out, and automatically the green light comes on and the machine goes on.

When I went through this plant the first time I was told by a top official of the Ford Motor Co.: "Mr. Reuther, you are going to have trouble collecting union dues from all of these machines."

And I said: "You know that is not bothering me. What is bothering me is that you are going to have more trouble selling them automobiles."

That is the real significance. We have mastered the know-how of mass production, and what we need to do is to develop comparable distribution know-how so that we will have markets for the tremendous volume of production that automation now makes possible.

I know that industry obviously will attempt to play down the impact of automation upon levels of employment, and I could give you the figures that the union has worked out. But I would prefer to give you a quote out of Newsweek as to what the impact has been in the Ford automated engine plants.

Newsweek reports that the production has doubled, with 10 percent of the work force.

That is the general overall impact of automation upon manpower in industrial plants. There is a radio plant in the East, where they had 200 workers assembling radios. They automated the assembly part of that plant, and 2 workers turn out now a thousand radio sets a day, where formerly 200 workers were required.

Automation, unlike the first phase of the industrial revolution, will, I believe, have a greater impact upon white-collar workers than upon industrial workers, because it is easier to standardize many operations that white-collar workers do in the clerical field than it is to standardize some phases of industrial production in terms of metalworking. We are going to witness not only a tremendous impact of automation upon the industrial worker, and industries employing industrial workers, but we are going to witness and experience a greater impact upon those industries in which clerical and white-collar workers historically have been employed.

Banks are already automating. These electric brains not only can make out the checks, but can store in their memories temporarily the facts that they have recorded on a check; when the check is cleared, they pull out of their memories the information and then make the final entries in the books.

Insurance companies are going to automate their whole insurance offices and lay off thousands of clerical workers.

Inventory control that required thousands and thousands of clerical workers throughout American industry is going to be automated. You are going to be able to know inventory facts much more quickly; in 30 minutes you will know an inventory picture that, by the old procedure, with hundreds of clerks working, would have taken weeks to get.

This impact is not something that is just going to affect the automobile workers or the chemical workers or the radio workers or the steel workers in what we consider to be the basic industries. It is going to have tremendous impact in every section of economy, and I believe a greater impact in the white-collar field.

Some people would have you believe that we have already felt the major impact of automation, but that is not true. We are just on the threshold of this new development. Automation is in its early infancy; in the years ahead, it is going to mature and the impact is going to be much greater in every segment of our economy.

The Journal of Commerce, on September 7, 1955, reported a survey made among 20 machine-tool companies at the time of the national machine-tool show:

> Their survey disclosed the belief that automation probably will make almost twice as much progress in the next 5 years as it has in the past 10 years.

I should like also to quote from a statement from Mr. M. A. Hollengreen, president of the Machine Builders Association. He said:

> Demonstrated advances in productivity are amazing. In case after case, new machines will do a job in a third, in a tenth, in one-fifteenth of the time formerly required. Advances in machine tools have never been as rapid as they have been in the past 5 years, and most members of the industry expect the pace to be stepped up considerably in the next half decade.

So here are two illustrations from business sources—not CIO propaganda, not A. F. of L. propaganda, not reports of scaremongers, as some people would have us appear in their propaganda, but reports from industry showing that we are just beginning to feel the tremendous impact of automation.

The CHAIRMAN. May I interrupt to say Mr. Hollengreen will be a witness before this committee, Thursday, October 27.

Mr. REUTHER. Very good. I am glad to hear that.

Mr. David Sarnoff, who is the chairman of the RCA Corp., made a speech, reprinted in a pamphlet entitled "The Fabulous Future." We would like to share his optimism with this committee. He said in his speech:

> The quality of new powers and processes at man's disposal is important, but even more important is the increasing speed at which these things have come. It is not a case of continued increase, but of continued acceleration of increase. We need only project the trend in the future to realize that we are merely on the threshold of the technological age.

That is exactly the point I would like to underscore, "we are just beginning." We are just beginning to get our big toe wet in the field of automation; when we wade in up to our knees, the impact will be tremendous; when we get up to our Adam's apple, it will be much greater.

Mr. Sarnoff goes on to say:

> The very fact that electronics and atomics are unfolding simultaneously is a portent of amazing changes ahead. Never before have two such mighty forces been unleashed at the same time. Together they are certain to dwarf the industrial revolutions brought by steam and electricity.

Now if every big business group in America shared that point of view and had a little bit of that vision, and then attempted to take that vision and bring it into focus in terms of practical, day-to-day problems that we need to meet, and solve, then we would have no problem. But, unfortunately, there are still powerful forces in the big-business community who believe that there are no problems. And that point of view is, I think, very well expressed in the pamphlet put out by the National Association of Manufacturers.

They put out a pamphlet called Calling All Jobs. Here is what they said:

> Guided by electronics, powered by atomic energy, geared to the smooth, effortless workings of automation, the magic carpet of our free economy heads for distant and undreamed of horizons. Just going along for the ride will be the biggest thrill on earth.

They think that you can solve the problems of tomorrow just like you sell toothpaste—just talk about bigger and better days ahead, the magic carpet will take us all to the promised land without effort.

Now there are bigger and better and finer days ahead, but we will not get there by some magic carpet. We will get there by meeting the practical problems that must be met in order to get to where we want to go. It is this kind of irresponsibility, this effort to brush the problems under the rug, that bothers us.

Here again we have a point of reference, a frame of reference. What did the NAM do in the period before 1929? Go back and read their propaganda. Go back and see what they were doing then. They were resisting every effort that was advanced to try to meet the problems that we failed to meet and that caused the problems in 1929. One year before that crash they would have had the American people believe that we were riding on that magic carpet, and that the possibilities for human progress were unlimited. All we had to do was to relax, and to have confidence.

Well, the trouble is that they always confused complacency with confidence. We want to have confidence, but we don't want to confuse it with complacency. It is this kind of reckless and irresponsible complacency that just says, "Let's ride the magic carpet to utopia" that frightens us, because that is why we got in trouble in 1929.

We believe that we need to wrestle with the practical problems. Only as we wrestle with the practical problems can we solve them: only as we solve these problems can we be certain that the productive power and the abundance now made possible by our developing technology in automation will be geared to the need of the people.

What are some of the problems?

Well, there is the problem of dislocation of whole communities. We know—and as automation develops to higher and higher levels of perfection this fact will be even more true—that in case after case it is more economic to build a completely new factory to house an automated production process than to attempt to convert or rehabilitate an existing plant.

What does that mean?

It means that in many cases industry will locate new factories that are fully automated, not in the areas in which the old factory was located, but in an entirely new area. And as we get into the peacetime use of atomic energy and solar power and the sources of industrial energy and industrial power are changed, it means that the locations of industry may shift from old to new areas.

Now, it is very fine for a corporation executive or a member of the board of directors to make a decision to locate a new plant that is going to be three times as efficient as the old plant in a new area, to build it in a cornfield and close down the old plant, but what about the people who live in the community where the old plant is located?

This is not some problem dreamed up to frighten people. Just go up to New England and go into some of the textile centers that have already become ghost towns. Go into some of the coal mining regions of Pennsylvania, where people have been unemployed for many years, and you can begin to visualize this problem. We have got to begin to think in terms of the impact of automation, the impact of this developing technology upon communities in which old factories are located.

Industry must begin to realize that it has an overall economic and social and moral responsibility to plan the location of new automated factories in terms of the impact of those new factories upon existing industrial communities.

This does not mean that forever and forever and forever an industry that is located in a certain geographical area of our country must remain there. When there are sound and compelling economic advantages to justify the relocation of an industry, then the industry ought to be relocated, but the economic impact of that relocation should not be forced upon the shoulders of the workers in the plant that was shut down, or the community in which that plant was located.

If the whole of society is going to gain an economic advantage by the relocation of that factory, then, since the whole of society gets the advantage, why should a small group of workers or one community have to pay the price?

These are problems that we need to meet. The Government and industry together must find a way to minimize the economic impact upon the communities directly affected, and upon the workers.

With respect to the broad community problem, obviously you are dealing there with a problem in which the Government has a major responsibility.

In the area of the problems affecting the worker, there are many things that need doing. First of all, the worker will have to be relocated. If he is a young worker, that problem is not nearly so difficult. If he is an older workingman, whose roots are deep in the community, who has spent his whole life there, the problem is obviously more difficult.

Industry must be willing to assume part of the costs of relocating workers. There is also the problem of retraining. It is very fine for industry persons to say glibly that a hand trucker who was eliminated by an automatic conveyor or belt today will become the electronics engineer of tomorrow. It is very fine, but it is not automatic.

If you are going to take a worker who is displaced by a simpler kind of technology and train him for integration into a more complex kind of technology, then you have got to have a training program to make that possible; the worker has got to eat while he is being trained, and his children must continue to have the basic economic things that they need every day in the period of training. We have got to do more than just glibly talk about the hand trucker of today becoming the electronics engineer of tomorrow. We have got to create training programs to facilitate the training and we have got to work out economic programs of assistance so that during the period of training and relocation the worker's family is taken care of.

These are long-range problems. We have got to recognize that in the broad sense we need to expand, not only our vocational training facilities, but also to broaden our facilities for higher educational training. We are falling behind. The Russians are training more engineers than we are. We can be smug in America and we can talk about how we are better, and in most areas we are better, but the gap, the difference between what we are doing and what they are doing is getting smaller and smaller. When they turn out more engineers and more technicians in their universities than we are turning out, it is just a matter of time until the impact of that greater effort in training engineers and technicians will begin to reflect itself in their rate of technological progress as compared to our rate of technological progress.

We need to raise our sights to provide more opportunities for people to get technical training, engineering training, and scientific training. We need to find a way to give more people in America, more of our young people, a chance to have access to educational opportunities at the higher level, instead of being barred or handicapped by the economic position of the breadwinner and the family in which they grew up.

Every child in America who can make a contribution ought somehow to have an opportunity to grow intellectually, limited only by his capacity to learn and understand. That means we need a scholarship program that will facilitate educational opportunities of every child, commensurate with the capacity of that child to grow, not limited by the economic circumstances of the family in which the child grew up.

We don't object to the relocation of factories where there is sound economic reason, providing that the community is protected, providing the worker is protected, and providing he is relocated and retrained, but we have no patience with the theory that says, "Well, this is a normal thing, this dislocation and relocation. It is a normal thing in a free economy. This is the worker's contribution to progress."

That is very fine, if you are taken care of, to have that theory, but it is very tragic if you happen to be the worker involved. We have got to recognize that these are developments and forces beyond the control of the individual worker, and beyond the control of the individual community. We need to think in terms of meeting these as an overall problem, requiring both governmental action and requiring greater responsibility on the part of industry itself.

Recently we have made progress in a direction which will help cushion these problems of relocation, retraining, and transfer. We now have almost a million workers in the auto industry, and related industries, covered by the guaranteed annual wage. We said from the very beginning that the guaranteed annual wage was more than a matter of economic justice to the wage earner; it was an essential part of the basic necessities of our free dynamic economy.

What happens if a worker is covered by GAW and he gets dislocated? The employer has an economic obligation. He has the obligation to continue to pay that worker during the period of his idleness, and you watch how much better job the employer will do in locating new plants if he has a continuing economic obligation under a guaranteed annual wage.

You watch how much better he plans the transition from the old factory to the new factory.

You watch how much quicker he can recall those workers, and how much more dedicated he is going to be to find an effective way to train them, so that they can master the new skills in the automated factory, where he has a continuing obligation.

We said from the very beginning, we don't want to be paid for not working. The guaranteed annual wage is not brought forward as a kind of glorified goal so that workers can get more money for idleness. Essentially this was an attempt to create new and powerful economic incentives for American industry, so that the cost of dislocation, unemployment, and these other economic costs would bear more heavily upon their shoulders and they would have greater incentive to work out a solution to these problems.

As the idea of the guaranteed annual wage is accepted in broader and broader sections of American industry, there will be these powerful economic incentives. Industry under the impact of these incentives will begin to act more responsibly in terms of the community problems, in terms of the problems of relocating and retraining workers.

In the field of population growth there is a real problem. Here, again, you cannot minimize it. According to the experts, our population will grow from around 165 million to 190 million within 10 years.

When you add the increase in the population, roughly 700,000 new workers coming into the labor force every year at the present time—a figure which obviously will grow—and you add to that the increase in productivity because of the new tools, you get a situation where we need now roughly 3 million new jobs a year, just to keep pace with the development in productivity and the increase in the labor force.

Within 5 years we will need roughly 4 million new jobs a year.

I say we have a right to ask ourselves, in the face of this problem, in the face of the increase in productivity, in the face of the increase in the labor supply: How well are we doing?

Well, we are not doing as well as we need to do, although we have made some improvement since 1954. We still haven't solved this basic problem.

In 1953, in September, there were 17.5 million workers engaged in the manufacturing industries.

In September 1955, there were only 16.9 million so employed, or 600,000 fewer workers.

Although 600,000 fewer workers were employed in the manufacturing industries in September of 1955 as compared to September of 1953, the production of those industries has gone up so we have greater production, with fewer workers. We have got to recognize that this problem will become intensified in the period ahead.

Those people who don't want to recognize this as a problem say the figures are true. They will say that the automobile workers and automated engine plants are turning out more engine blocks with fewer workers, but they say that is only part of the story. There are more workers engaged now in making the automated machinery that makes the engine block, and the difference is absorbed there.

Well, I say that the sheer logic of the situation disputes that fact, because the Ford Motor Co. and General Motors Corp. don't spend billions of dollars to automate and modernize their factories just because they want to minimize direct labor costs and increase indirect labor costs. There is a net saving, and they are spending billions to modernize in order to reap that saving.

The Department of Labor recently put out a statement which I think bears upon this point. Their statement reads as follows, and I quote:

ELECTRONICS OUTPUT

> The electronics industry is one of the key industries in this whole automation process.
>
> The electronics output in 1952 was 275 percent higher than in 1947, but was produced by only 40 percent more workers.

Here is an example, you see.

In other words, they are automating the automation factories. They are automating the factories that make the machinery to automate the production of engines. General Mills is a company that has done a great deal in this field because they got in this business in the food processing and packaging industry. They produce a great deal of machinery that goes into what we call the automated technical process. And they have done a great deal toward building what they call the Autofad, which is the automating of the technical process of building automation equipment. That sort of thing is going to develop very fast. You are going to find the automating machine industry that makes the machinery that the auto industry uses, the electrical industry uses, is going to be highly automated itself. They are going to turn out a larger volume of machinery, with fewer and fewer workers involved.

Now, we would like to suggest and recommend that in order to meet this challenging problem—greater productivity, higher labor force—we need to be working constantly at the problem of maintaining a dynamic expanding balance between greater productive power and greater purchasing power.

We believe that one of the things that needs doing is to give consideration to lowering the retirement age from 65 to a lower age, so that people can be retired earlier and can enjoy a longer period of retirement, where they can have high standards of economic security and a measure of human dignity.

This means that we have got to put effort on the privately negotiated pensions plans and on social security through appropriate legislation.

We need also to cut down on the size of the labor force, not only by earlier retirement but by extended educational opportunities, so that people, since they will require greater technical skill, will be in school longer, and in that way we will shorten the labor force in terms of age groups, at the low end and at the high end, making full use of those people who come between those two age groups.

But the problem will not just be met by these things alone. We obviously are going to fight for higher wages, and we need to fight for lower prices. I think that basically we have got to recognize that our problem is the imbalance between production and distribution.

The chairman of this subcommittee certainly knows the problems the farmers are having. Their problem is not production; their problem is distribution. That has been our basic problem all these years. The farmers of America are not getting their share, their fair share, of the national economic wealth that is being produced. They have done a tremendous job producing the foods and fibers that we need as a free people, and yet their problem is that we haven't learned to distribute the products of our farms.

We in the labor movement are working on that. We know that we are the best customers of the farmers and we know that they are the best customers for the things we make, and we know that we can't be prosperous unless they are prosperous. We don't think that they can be prosperous unless we are prosperous. We know that they lost their farms in the dark days following 1929 because millions of factory workers had lost their jobs, and we know that their economic well-being is inseparably tied together with our economic well-being. So when we fight for higher wages, we are fighting for more purchasing power, more purchasing power to buy the things the farmers raise, more purchasing power to buy the things that we make in the way of consumer goods. We know that when a farmer has more purchasing power, he buys more clothing, he buys more equipment, he buys more of the things that we make in the factories in which our workers are employed.

One of the things that bothers us and one of the things that we have got to get into as a part of this whole problem of automation is the question: "What share of the economy is made possible by automation; what share of the reduction in unit cost of production is made possible by automation; what share of the reduction in cost are the consumers entitled to in the way of a reduction in prices?"

Unfortunately, we are making no progress in that direction, compared to what ought to be done.

Recently, the steel workers got a wage increase, and the steel industry, as has been the case in the past 20 years, increased prices. Every time the industry gives the workers 50 cents more in wages it jacks up the price of steel $1, and then attempts to make the workers responsible for the price increase.

The profits of the steel industry were sufficiently high to absorb the wage increase without any price increase.

I think that Congress ought to begin to check into this whole question of the wage-price-profit relationship, and find out who is respon-

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sible for the price increases; find out whether the lust for greater and greater profits is not really the reason why prices were jacked up, not because the wage increases required higher prices.

Take the auto industry. Chrysler and Ford have both raised their prices. They needn't raise their prices. We haven't got the final figures on the profits of the Fort Motor Co. because it is a family-owned corporation, not one that you can get all the figures on, but we know that they are proportionately doing almost as well as General Motors, and we do know how well General Motors is doing.

The General Motors Corp., in the second quarter of this year, made a profit of $734 million, in 3 months. They haven't come out with their new models yet, but I suppose when they do, they will follow Chrysler and Ford in their price adjustments, but they needn't. There is no reason why the efficiency of automation cannot be shared by the American consumers. These corporations need not pass on the wage increase in the form of higher prices.

General Motors could pay the wage increase and cut the price of their cars, and still make fantastic profits. We believe and we have been urging Congress to investigate this thing so that all the facts could be placed on the table. The economic and moral responsibility for higher prices then could be pinned on the back of that economic group that is responsible.

If labor is responsible, and the economic facts show that, then we should be held responsible.

But if the lust for higher profits is the area of responsibility, then the people who are responsible for that drive for greater profits ought to be accountable to the American people.

The Secretary of Agriculture made a speech down in New Orleans some weeks ago, and he said, "It is just terrible how the farmers are getting further and further out of line in terms of their economic position," and I agree with that. Their economic position continues to deteriorate. The things that they have to buy are going up in prices, but the things they sell are going down.

Then the Secretary of Agriculture went on to say—and this is a part of a well-thought-through political campaign of propaganda—that, "Of course prices had to go up, because the workers got a wage increase." And I invited Mr. Benson to join the efforts of my union, the auto workers, to try to get a congressional investigation to find out what the facts are.

Well, to date Mr. Benson has chosen not to join forces, because he well knows, as we know, that the culprit is not higher wages but the culprit is the drive for higher profits on the part of big business in America.

We hope that somehow Congress will get around to checking into this whole question of wages, prices, and profits, because this bears directly upon the whole question of the sound use of the efficiencies and economies of automation.

Who gets the benefits? If the consumer shares in the benefits through lower prices, if workers share by higher wages and greater purchasing power, then we are dealing with the basic facts of keeping in balance greater productive power and greater purchasing power.

The thing we have got to realize is that the minute we get out of balance all of the forces that made for the first imbalance begin to compound the imbalance and build on it very quickly.

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That is why in 1954 we were in trouble in the auto industry. The auto industry was the single most important industry that had stimulated demand and purchasing power; the minue we began to get in trouble the whole economy began to get in trouble. If we don't make automobiles, they don't make steel, rubber, and the thing backs up.

In Michigan alone unemployment in 1954 cost the wage earners in the manufacturing industry alone $640 million loss in wages. Nothing breeds unemployment like unemployment because, when a worker is unemployed, he curtails his consumption and then the things that he would have bought that somebody else made are not purchased and the fellow who would have made them gets laid off. This thing begins to compound; it begins to snowball.

Therefore, what we need to do is to find a way to build into our economic system adequate cushions and safeguards to prevent the compounding of the negative economic forces that make for imbalance to begin with. Therefore, we believe that unemployment insurance needs to be raised to realistic levels, to begin to meet the basic needs of workers during periods of layoff, so that we don't withdraw them from the active field of consumption, but sustain their consumption at high levels, so that this compounding of negative impact is held down if not entirely prevented.

We need to raise the level of the minimum wage.

Congress made some progress to a dollar, but a dollar an hour measured by the technology that we are now dealing with is unrealistic. It is inadequate. We believe that it ought to be raised to $1.25 as the next step in the right direction.

We need also, Mr. Chairman, in human terms and as part of the long-range program to harness the power and the productive capacity of automation, a realistic program of school construction. We need 600,000 new schoolrooms right today. And with the growth in our population, we will need many more in the years ahead.

Here is a job for America to which we need to apply our technology and our economic resources.

In the field of housing, we need to build 2 million new units every year, to wipe out the slums and to accommodate the growth in our population.

We need 800,000 new hospital beds right now. We need all of the other medical facilities, both on a training end and on the service end, to meet our basic needs.

We have need for a tremendous highway construction program; and parking lots. It is not enough just to build new roads because, after you get to where you are going, you have to have a place to park your car. We have a tremendous problem there.

We have the whole problem of flood control. Look at New England now. Twice within a couple of months, New England has been struck hard by floods. And, of course, we have the broad resource development program that we have got to work on continually.

If we take on all these programs—school construction, housing construction, hospitals, roads, flood control, resource development, we believe we can maintain full employment and full production. But when we get to the point where we begin to meet these basic needs, then we need to think in terms of a shorter workweek. As the tools of production make it possible to satisfy our basic economic and material needs with fewer and fewer hours of work, we need to be thinking in terms of a 35-hour week, a 30-hour week, a 4-day week, which I prefer to a 6-hour day. I would prefer to work 8 hours a day, get your time in, and get away from the factory, so you can go away for a weekend for 3 days with your family.

This will mean not only greater leisure, but the development of whole new industries to meet the needs of people who are spending their leisure on a wholesome, constructive basis. These things will not just automatically take place. We have got to be thinking in terms of these long-range problems.

We believe also that small business is going to need a great deal of help during the transition period. We believe, further, that we need to reevaluate our historic antimonopoly policy, because more than just the size of industry is involved in whether it is monopolistic or not. Questions of broad social policy enter into this thing.

I believe we need to think through and reevaluate the whole concept of how a free society deals with the problems of monopoly and how we protect the free enterprise characteristics of our economy in a period of automation.

We would like to suggest that your committee, or some other appropriate committee of Congress, continue a study of the problem of automation. One of the real needs is to provide some appropriate clearinghouse through which you can channel the total information on the problem of automation.

I believe that the General Motor Corp., or the Ford Motor Co., has a very good idea of what automation is going to hold 10 years from now, or 15 years from now, as it applies to the automotive industry. I think GE and Westinghouse have a very good concept of what automation is going to do to their industry. But General Motors doesn't know the electrical industry and the electrical industry doesn't know the automotive industry, and neither does the chemical industry know some other basic industry. There is no central clearinghouse through which the total information can be channeled so that the Government and the people of our great country can have a look at the total picture. It seems to me that an appropriate continuing study committee of Congress can provide the clearinghouse through which we can maintain an up-to-date inventory of the developing information and knowledge in the field of automation and related technologies. Therefore, we would like to urge that you give consideration to a continuing study committee that periodically will bring up to date the inventory of the information and the knowledge and the problems that automation is developing and presenting to us as a free people.

It is in the areas I have mentioned that we would like to have your committee continue to give study. We should get more light and less heat on the problem. Industry should not go out to try to make it appear that labor is raising all sorts of unnecessary fears, and begin to put the tag that was applied to us some years ago, that we were the fearmongers; nor should labor go out and attempt to exaggerate the problems in order to create a situation in which they can exploit the fear. What we need to do is to look at it honestly and realistically and realize that free labor and free industry, free agriculture, and free government have all got to work together to find the common answers to these common problems.

Personally, I believe that we can find the answers. I have unlimited faith in the future of the American economy. I have unlimited faith in the good sense of the American people, and I believe that somehow we will find the answer to this problem, but we will find the answers only if we understand the problems and work at solving them.

That is why we have come here today, to urge that we work at this problem with honesty, and with realism, and with an understanding that we are all in the same boat, whether we are from labor or industry or agriculture, or some other segment of the American economy, and that somehow we need to find the answers to these problems.

We believe that the possibilities for human progress and for technological development are as unlimited as the general use, the creative general use of the free human spirit. There is just no limit to where this thing can go. What we need to do is to recognize that the horizons are unlimited in the field of scientific and technical development and what we need to do is to work to develop both the know-why and the know-how in the human and social sciences, in the art of translating the great technical progress into human values, into human progress. Only as we do that can we meet this great challenge.

I think we can, and I hope that the committee hearings that you are holding here will afford labor and industry and other people an opportunity to come here, express their point of view, and out of this information and knowledge, you can make recommendations that can help to guide people in industry and labor, and that can be recommendations upon which positive legislative action may be taken.

I appreciate the opportunity to testify, Mr. Chairman, and if there are any questions I will be glad to try to answer them.

The CHAIRMAN. Thank you very much, Mr. Reuther.

I recognize this problem as one of our greatest and most difficult problems right now. For that reason I am going to listen attentively to every witness who comes before this committee. I know that other members, although they cannot be here in person for reasons that are good and sufficient, will study this testimony. The testimony, of course, will be made available to the House and Senate for their consideration, because as you say, we must consider it now and have vision to look into the future.

You mentioned the New England floods. Would it be feasible to have an authority up there similar to the one they have in the TVA, that would correct the troubles that they have?

Mr. REUTHER. Well, I have always been very pro-Tennessee Valley Authority because I believe that a river has to be looked at as a total, and a local community, or a State or a group of States through which a river goes cannot by themselves deal with the problems of that total valley. An authority in terms of the total river valley is a much more realistic and effective approach to the problem. I would certainly feel that the lessons of the TVA could be applied in many respects to the problems of the New England areas.

The CHAIRMAN. Do you know what consideration is being given to working out something along that line?

Mr. REUTHER. There have been some discussions up there in which we have participated. I am not familiar with the details. I know there are some discussions about the power problem of New England and other problems relating to the river developments.

The CHAIRMAN. I appreciate what you said about the farmers. I agree with you, that labor has a problem in common with the farmer, and the farmer has problems in common with the worker. I thoroughly agree with what you say on that.

As to high profits, I see another evil. I wonder if you have given consideration to it. If the large concerns are able to get their expansion capital from higher profits and retained earnings, that denies the saver of an opportunity of investing his funds at a profit. In other words, there will be no demand, or not as much demand for equity capital. Have you given consideration to that factor, too?

Mr. REUTHER. We have discussed that on a number of occasions. What is happening is that American industry is making tremendous profits, and the plowing of those undistributed profits into expansion and improvement instead of to the stockholders is, I think, changing the character of American capitalism. It is an old theory when you wanted to build a new factory you went out and sold stock or borrowed money and people invested in the factory by buying your stock or your bonds. That is being changed a great deal, because much of the expansion now is being financed by plowing into expansion the earnings of an industry.

The CHAIRMAN. Over and above fair profits.

Mr. REUTHER. Over and above a fair profit.

The CHAIRMAN. Which is really costless capital.

Mr. REUTHER. In a sense, that is exactly what it is.

The CHAIRMAN. What chance does a small concern have, in distribution or manufacturing, when the young operators go into the market and they borrow their money and have to pay interest on that money? What chance will they have in competition with a factory unit across the street that has been built with costless capital?

Mr. REUTHER. You can understand why small business is in trouble for precisely that and for many other reasons. It is very nice to say that under our free enterprise system anybody who has an idea for a new mousetrap or new automobile can go out in the market and raise capital and start himself a business, but I would warn anyone who is going to take on General Motors or Ford that it is pretty risky business; that the prospects of survival are not too great because you are up against powerful corporations whose volume makes it possible to reduce the unit cost of production very low, and whose profits are tremendous. Let me get back to this General Motors profit figure.

They could have paid us, for example, in the second quarter of 1955—they could have absorbed the total cost of our economic package, wage increase, GAW, higher pension benefits, improved medical care and all of the other things—the total cost of that could have been absorbed by the General Motors Corp., and the impact upon their profit position would have reduced their profit from 42 percent return after taxes on their net worth to 39 percent return on their net worth, and how a company like that can wind up by charging higher prices for their products is beyond me to understand.

The CHAIRMAN. 42 percent in less than a 2½-year period.

Mr. REUTHER. That is right. At the end of 2½ years you own it—you get it back in dividends but still own it. It is not true there is not a Santa Claus, because there must obviously be one.

The CHAIRMAN. You said over $700 million in one quarter. What is the exact figure?

Mr. REUTHER. $734 million.

The CHAIRMAN. Does that mean nearly $3 billion for the year, then?

Mr. REUTHER. If they sustain that rate for four quarters, it would mean that much. Of course, they won't because they will have a certain model change period, etc.

The CHAIRMAN. That is what you consider the 42-percent profit?

Mr. REUTHER. That is right. In the third quarter they earned 42 percent after taxes—42 percent after taxes—42 percent on their net worth, at an annual rate. If you projected that, if they earned for a year what they earned in the second quarter, they would have earned at an annual rate of 42 percent profit on their investment, after taxes.

The CHAIRMAN. The farmer, of course, as you mentioned, has a problem in distribution. You know the little farmer is being squeezed out entirely, in somewhat the same way as are the older workers.

More and more they are turned off and they go out and they receive this unemployment pay a while. They go back. They can't get back on, because their age is against them. It used to be in our country, in farming areas, they could at least turn to farming. It was a good cushion, a backlog. Now they can't get an allotment to grow. The big planters, of course, are profiting mighty well.

I don't have any prejudice against large planters, or big business, or anything else. They all fit into our scheme of things, but we have got to give some consideration, I think, Mr. Reuther, to the distribution of opportunities among farmers, as well as distribution of their products.

Mr. REUTHER. I agree with you completely and I want to say this, that you get legislation introduced in this Congress to help the farmers who farm the land, and you will find the CIO and the entire labor movement down here supporting that legislation. One of the things that bothers us is that too often farm programs help the farmers who farm the farmers and not the farmers who farm the land. We think the family-sized farmer is the fellow who needs the protection, and if legislation is introduced to give them that kind of protection, you will find the American labor movement down here supporting it wholeheartedly.

The CHAIRMAN. I think we will need a program like that to help the family-type farmer, and I have heard your statement and I am very much heartened to know we would have the support of a great organization like your own.

The agriculturalist, of course, is the fellow who farms the farmer, and the agriculturalist is the person that is making a lot of money out of this program. I think we had better take another look at it.

Concerning the retirement age, you didn't make a suggestion as to what that age should be. Do you have in mind any age that the retirement age should be changed to?

Mr. REUTHER. I think as the first step it ought to be brought down to 60.

The CHAIRMAN. What about the women?

Mr. REUTHER. It depends upon the type of industry they are in. I think if you could go on the basis of a general reduction to 60 and then where people were in heavy industries, where the strain is much greater, you might consider a special earlier retirement period. I think an overall reduction to 60 would be the first step in the right direction.

The CHAIRMAN. Now when a person, say, 45 or 50 years of age, attempts to get a job, to do any kind of work—he is told that he is too old, that the insurance company will not take him. That is given as the reason why they will not give him a job. Is that the only reason they are refusing to take them, because they can't be covered by insurance?

Mr. REUTHER. That may be a reason in some cases. It is not a good reason, because obviously, if industry wanted to get these people covered by insurance, they could.

The CHAIRMAN. They could, however, get these older workers covered somehow?

Mr. REUTHER. Yes, sir.

The CHAIRMAN. Could that be handled by law someway so as to prevent discrimination against these older workers? Have you given consideration to the kind of legislation if any, which would be helpful in that direction?

Mr. REUTHER. We have not discussed meeting that problem by legislation. We have been appealing to the employers, however, to be willing to employ workers who have been displaced, despite their age. Some progress has been made in a number of areas but I think, by and large, most industries still refuse to hire workers after they have passed 45 years of age. They prefer a young fellow.

There was some claim that the pension programs had discouraged hiring older workers, but that is not true, because if you hire a worker at 45, that doesn't cost the employer, under our pension plans, any more than if you hire a worker at 25, because he merely has to build up future service credits at a certain rate, based upon the wage of that worker. But a lot of these things have been raised as excuses to justify the refusal on the part of management to employ workers beyond 45 years of age.

We believe that when a worker is displaced, if he is 45 or 50 years of age, he ought to be employed, based upon his ability to do the job, without regard to his age.

As far as the union is concerned, there are no obstacles that we have put in the way that prevent an employer doing just that.

The CHAIRMAN. You think then that they are giving excuses rather than reasons for not employing these people?

Mr. REUTHER. I do.

The CHAIRMAN. You mentioned awhile ago about a plant doubling its capacity with 10 percent of the workers. Would you elaborate on that a little bit more, to tell us about the number of workers before and the number of workers after?

Mr. REUTHER. Well, I was quoting from Newsweek because I said that at that point that it might be more convincing to do that than to give you figures from labor sources. I can get you the citation on that.

The CHAIRMAN. Yes, sir; that is all right. That is not too important.

Mr. REUTHER. The auto workers have put out a pamphlet on automation which we would be happy to supply.

The CHAIRMAN. Thank you, sir. We will be glad to have it. In fact, I have seen one.

(Mr. Reuther subsequently submitted the following section on automation taken from a report to the UAW–CIO Economic and Collective Bargaining Conference, November 12, 1954:)

The dictionary as yet does not contain a definition of "automation," but already it is making striking changes in our industrial system. Some management spokesmen say automation is "the automatic handling of parts between progressive production processes"; others claim it is "a new philosophy of design, a new manufacturing method." Regardless of definition, however, technological developments involving the greater use of automatic machinery and the automatic regulation and control of this machinery are giving rise to radical changes in the factory. These changes, sporadic at the outset, are now constantly increasing in velocity and volume. The Republican tax bill changing the basis for the calculation of depreciation may tend to accelerate the scrapping of existing plant and machinery and their replacement with new and more efficient equipment and facilities. The manager of the new Ford foundry in Cleveland gave a graphic idea of the kind of changes which are taking place when he stated:

"Ours is the only foundry in the world where the molding sand used to make castings is never touched by human hands except maybe out of curiosity."

Automation may be the forerunner of a second industrial revolution which will have a greater impact throughout the world than the first. Or technological developments may come more slowly and gradually without causing major changes in economic and political institutions and relations. The experts disagree on what the future holds. One says automation is only "a new chapter in the continuing story of man's organization and mechanization of the forces of nature." Another says that automation "will produce an unemployment situation, in comparison with which * * * the depression of the thirties will seem a pleasant joke."

A third, who believes that the new electronic computers will be linked with automatic machinery to produce robot machines, believes that "we should set up a Robot Machine Commission, with the duty of formulating social policy on the speed and circumstances of the introduction of robot machinery and with power to speed up or delay its introduction according to what the public welfare demanded."

Already there are examples where relatively few men do the work which formerly was done by many. According to Newsweek: "Ford's automatic engine plant turns out twice as many engines as an old-style plant, with one-tenth the manpower."[1]

Approximately 10,000 men in the foundry and engine divisions of a major auto company now turn out the same production which formerly required more than 23,000 men. Only a large increase in total output prevented wide-scale layoffs in those divisions.

These developments are not confined to the industries with which the UAW bargains but extend throughout the economy. Newspaper articles revealed that "a radio assembly line geared to produce 1,000 radios a day, with only 2 workers needed to run the line [is replacing] standard hand assembly [which] requires a labor force of 200."

Automatic controls have been widely introduced in the petroleum industry. One industry spokesman stated: "The average refinery which would employ 800 people without instrumentation would employ 12 people, were instrumentation utilized to the fullest extent possible."

A prominent Harvard economist has stated that it would take approximately $600 million to provide the necessary controls and instruments to automate all the plants built in 1950. During that year about one-tenth that sum was spent for that purpose. One indicator of the rate of adoption of automation is the output of the "industrial recording and controlling instruments" industry. In 1951, according to this same economist, the sales of these instruments doubled. And, if the upward trend in expenditures to automate industrial facilities continues, American industry may be fully automated within a decade. This, according to another economist, will mean that 1 man will do at least the work now done by 5 men. These predictions, if accurate, would mean, for example, that 200,000 men could match the present output of the million UAW members in the automobile industry.

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[1] "Certainly anyone who is worried about the effect of machines on employment can find examples to bolster his fears. When the Bell System installed automatic long-distance dialing in Boston a few years ago, a newspaper report pointed to the 'one bitter note seeping out from the proud new telephone building and its wondrous insides'—450 toll operators received their termination notices. Ford's automatic engine plant turns out twice as many engines as an old-style plant, with one-tenth the manpower. It's been estimated that, in an office, 1 machine could do the work of 200 to 500 clerks."—Robot Machines and Men: Is a New Age in the Making? Platform, October 1953, p. 19, published by Newsweek Club and Educational Bureaus, 152 West 42d St., New York 36, N. Y.

The possibility of dramatic technological advances emphasizes the need for an expanding economy built upon the broadest possible purchasing power base. Automation will increase productivity, but increased productivity without increased total production is a formula for depression. If productivity is increased within a framework of full production and full employment, the Nation will prosper. If automation is irresponsibly introduced and exploited, it will bring unemployment and misery instead of security and abundance. The radical productivity increases which will accompany automation make it necessary to intensify the fight for an economy based on full production and full employment.

The key to success in this struggle is increased purchasing power in the hands of the people. We must be able to purchase the goods we produce. And, when our productive power increases, our buying power must also increase. The UAW-CIO will make its contribution toward this end by insisting at the bargaining table that purchasing power be increased sufficiently to match our productive capacity. But high hourly rates of pay for our members are not enough. Steady work is essential week by week, month by month, the year around.

The CHAIRMAN. On this relocation problem that you mention, I consider that very serious problem. Do you have any suggestion to offer as to the type legislation that would be helpful, if you believe legislation would be helpful?

Mr. REUTHER. Well, rather than just discussing it off the cuff, I would prefer if we sat down and worked out a more comprehensive plan, because there are many aspects of this problem that need to be met. I think the experience in some of the New England textile communities would give you the basis for trying to meet the problem.

As I said before, I think the Government has an overriding responsibility. I think the employer has a responsibility. I think that if they both meet their responsibility, the problem by and large can be met satisfactorily.

The CHAIRMAN. You mentioned a scholarship program. I gather from what you say that you are in favor of Federal aid to education. You believe education is a national, rather than a local problem?

Mr. REUTHER. Yes; I do not believe that the tax structure of the average city or county or State is adequate to meet the present-day educational needs. I believe that since the Federal Government has greater taxing capacity than do these local governments, it must assume increasing responsibility in the field of education. Therefore, we have urged Federal aid to education for a number of years.

We do not believe that the deficit, which is a very serious one, can be overcome, unless the Federal Government does greatly step up the aid which it provides to local school groups.

The CHAIRMAN. We were denied the privilege of using a lot of young men in World War II and subsequent to that time because of the lack of education.

Mr. REUTHER. That is right.

The CHAIRMAN. To that extent it would be a national problem?

Mr. REUTHER. I think it is one of the great tragedies. I think America should be ashamed of what we are doing in the way of educational opportunities. We spent, in 1 week of the last war more than we spend in a whole year for education in America.

I say there is something wrong with moral fiber and standards when we are not willing and able to spend as much per year for the education of our young people as we were willing and able to spend under the compulsion of war. There is just something wrong. You can get appropriations through Congress without too much difficulty to make super H-bombs or battleships, or super jet planes—nobody says we cannot afford it. This is a necessity. We are defending ourselves. They just give you all the money we need. But when you talk about better schools, better housing, better medical care, more liberal social security, and these other things people say "We cannot afford these things." But we can afford them.

One thing that we cannot afford is to continue neglecting the educational opportunity of our children because down the road future generations are going to pay a tragic price for that.

The CHAIRMAN. If you place the burden entirely on the local communities, where a lot of people would like to place it, the local communities will have to go into debt. They will have to issue bonds. All bonds of the States, counties, cities, political subdivisions, are tax-exempt bonds. That sets up another private group in our country who pay no taxes whatsoever. Income from those bonds are exempt from taxation, whereas the Federal Government securities, if you were to raise the money that way, as you suggested, would certainly be taxable.

Now as to the full employment act of 1946—I believe I have heard you say that you are in accord with the objectives of that act. Do you think it has been working satisfactorily and has been helpful to the country?

Mr. REUTHER. I think that we got in trouble in 1954 because we weren't vigorously applying that act. We were just relying upon the free market place, and there are times when the free market place is not adequate to assure that we will continue to have full employment and production. We have always been in favor of trying to make the Employment Act of 1946 more effective, by building into it more effective machinery for implementation. Of course, in addition to having machinery, also you have to have the will to use it, and that essentially is an administrative decision and not a matter of the act of Congress. Congress can write the law, but the law has to be administered by the executive branch of Government. Unfortunately, I think there was a lack of will on the part of the administration back at the latter part of 1953 to use even the inadequate tools that are provided for in the 1946 Employment Act.

We kept urging them to use it, and it was only after things got much worse that they even began to do a litte bit. We are in favor of a better law, but we also know that the spirit and intent with which the law is administered are critical.

The CHAIRMAN. In other words, a good law can be a bad law if it is poorly administered, and a bad law can be made a pretty good law if it is properly administered?

Mr. REUTHER. If I had to choose between a weak law administered vigorously or a strong law administered weakly, I would take the weaker law with strong administration.

The CHAIRMAN. The administrator has much to do with it, of course.

Mr. REUTHER. That is right.

The CHAIRMAN. The purchasing power question which you raised is very important. I was here when we had the hard times that you were speaking of a while ago, from 1929 through the thirties, and I felt that the problem then was not overproduction but just underconsumption, because of a lack of purchasing power. People just didn't have the money. If we had had some way to distribute the money I think we would have brought this country out of depression rather quickly and rapidly.

Do you recall that was the reason I advocated paying the soldiers a bonus from the First World War? That would have distributed about $3 billion to about 3½ million men. I feel now that a lot of the Members of Congres will agree that if we had paid that money it would have started our country back on the road to recovery. Purchasing power is what was needed at that time. We have got to keep in mind at all times, as you say, gearing it to the needs of our economy, so that we will have greater and greater production, at the same time greater purchasing power, balanced with that production. Otherwise, we would be out of balance again. I think your analysis of it is a sound one. I hope we can carry it out that way.

Have you made a statement on installment buying?

Mr. REUTHER. Not recently.

The CHAIRMAN. There is an effort being made now to dampen and retard installment buying.

Mr. REUTHER. There is no question about it, installment credit is being expanded very rapidly, and that we could get in trouble down the road if we base future prosperity only upon the expansion of consumer credit. That is why higher wages are important. That is why the tax law that you people are going to have to pass this coming session of Congress is very important. If Congress gives the tax relief to the big corporations, and the wealthy income groups, then obviously that is not going to get more purchasing power into the economic stream. If you do as we hope you will, raise the personal exemptions from $600 to $800, you will be putting $4½ billion of high velocity purchasing power into the economic stream by giving the low- and middle-income families that much more purchasing power. It is that sort of thing that must be done to offset the continued expansion of consumer credit. If people have tax reductions so that they can spend more of the money now that is going to taxes for consumer goods, if they get higher wages, greater income, of course, they will not have to borrow future earnings in order to sustain their levels of living at the present time.

What you do on the tax front will be very important as it relates to this problem of the expansion of consumer credit.

The CHAIRMAN. You made a statement about the number of new workers every year that we must provide for. I believe you said about 3 million a year, this year or next, and in 5 years about 4 million a year. Do you believe that an increase or expansion of our gross national product, say, 3 or 4 percent a year, would be sufficient to take care of that?

Mr. REUTHER. It will not.

The CHAIRMAN. What do you estimate it will take?

Mr. Reuther. I think it will take a minimum in the next several years of 5 percent and beyond that it will have to step up to 6 and 7 percent.

The Chairman. Where do you anticipate this will finally balance and level off?

Mr. Reuther. It will never level off. The rate of growth may taper off, but it will never level off, because the very nature of our kind of dynamic economy requires continuous growth. I just think you cannot put a ceiling on the growth, either, in terms of the overall expansion of the American economy or the measure of increased productivity. We have had this discussion in the automotive industry because originally they claimed that the average overall increase in productivity was 2 percent. When we worked out our first wage agreement that gave the worker a claim to a share in increased productivity, we worked out what we called our annual improvement factor. It was based upon 2 percent a year. Now it is up to 2½ percent. We know the true figure is more than 3 percent. It is much more than industry is willing to agree because the minute they say it is as high as it is they know that we will be back at the bargaining table using their figures to support our arguments. They keep underestimating the level of increased productivity.

I personally think that it is somewhere around 4½ to 5 percent, as a conservative figure, and it will continue to rise as we improve our technological processes.

The Chairman. That being true, we will have to increase our debts. Under our capitalistic system, which is the finest system in the world, I think, supported by the finest commercial banking system, we must increase debts in order to expand our economy, because purchasing power is based on debt.

Don't you think it will be more helpful for that debt to be increased, if necessary, through sound installment buying, since in that way people can get needed comforts and the necessities of life? If you have got to have debt anyway, why not installment debt rather than add to the national, or Federal debt? Then if there is danger of inflation, instead of stopping the fellow who is buying something he needs, why not pay off some of the national debt so as to reduce the aggregate debt and keep the country in balance? Have you given any consideration to that, Mr. Reuther?

Mr. Reuther. Generally, our attitude concerning the question of debt has been that the size of the debt is not an absolute thing. It is a relative thing. You have got to measure the debt of an individual, or of a nation, based upon the level of their economy, and the efficiencies of their tools of production. We have never been greatly disturbed by the size of the national debt because when you measure it by the national income, and the productivity of our expanding economy, the size of the governmental debt is not very great. It is convenient around election time to beat it like a dead horse, but the fact is that it is not a very large debt, compared to the wealth that we collect each year in our national economy, and when measured against the possibilities of even greater wealth in the future.

The same thing is true of an individual. A debt on the part of an individual has got to be measured by the earnings of that individual. If the debt gets far out of proportion to the earnings of that individual, then it can be troublesome. The consumer debt doesn't get serious until you develop a little unemployment, because at that point a worker's income in curtailed, and his debt compared with his curtailed income then is no longer manageable; he cannot meet payments; he is foreclosed, and then you get a compounding of the negative economic factors that I was talking about.

That is all the more reason why, at the point we get some temporary unemployment—and nobody thinks that in a free economy you can always have a continuous line; there are going to be fluctuations, temporary unemployment—we should have adequate cushions supplied either by the UAW contracts or adequate unemployment compensation levels or both. Then the worker's income is not curtailed so drastically that the debts he may have get beyond being manageable.

So that really, the debt of an individual, or a nation, is something that has to be measured upon the income of that nation and based upon the income of the individual. If they maintain a certain ratio, then there is no problem. It is only at the point that the debt becomes larger in terms of its proper relationship to income that the problem develops seriously.

The **Chairman**. Mr. Frischknecht, did you want to make a statement in the absence of Senator Watkins?

Mr. **Frischknecht**. Mr. Chairman, and Mr. Reuther, Senator Watkins from Utah, a member of this committee, is unable to be in attendance today; as I explained last Friday to the chairman and to the witnesses on that day. The Senator is down at the American Mining Congress Convention. He will subsequently be on his way to the National Reclamation Association Convention in the Midwest. So, on behalf of Senator Watkins, I want to thank you for your very able and comprehensive statement this morning.

I think you have given the members of the committee here considerable fruit for thought. I am sure if Senator Watkins were here he personally would express the same sentiments.

There are only 1 or 2 questions, Mr. Chairman, that I would like to ask Mr. Reuther.

You mentioned this matter of resources development, as playing a very fundamental part in our economy. I wonder if such projects as upper Colorado River project might not help in this adjustment phase with respect to automation, the matter of economic fluctuation, and if such projects might not well facilitate our growth in gross national product, which you mentioned a moment ago, as being rather essential to maintain maximum employment in the economy?

Mr. **Reuther**. I think so. I think what needs doing is to have the private sector of the American economy carry as much of the load as possible; that we ought to have projects in reserve. At the point where there is a tapering off of the private sector and we begin to develop a serious problem of unemployment, we can then pull out of reserve some broad project of resource development which we can feed in early enough so that the lag time doesn't delay the corrective impact.

Mr. **Frischknecht**. Of course, this upper Colorado River project is such a project; isn't it?

Mr. **Reuther**. I would say that in development of our major river valleys in terms of achieving from them their maximum power potential, flood control, water resources, and so forth, we should have the plans worked out in advance. The engineering work would not begin at the point the trouble started in the private sector, but it should be done in advance, so that as it appeared that the private sector was going to develop a certain tapering off we could begin to feed into the economic stream these projects by ordering steel and other basic materials needed to get construction under way.

If we did that at a point where the corrective impace was felt, and we get back to a healthy, full employment—full production basis, you might taper off on some other project. I see the one supplementing the other; if we do our work well and plan far enough in advance, one can supplement the other.

Mr. FRISCHKNECHT. Then, of course, we have this other factor, that once the project, or some of the projects under a river basin development such as the upper Colorado River, then we find the creation of new wealth, new jobs, new sources of income, new markets. That is what we have in this type of project; is it not?

Mr. REUTHER. That is exactly what the development of such a project will do. It is exactly what the development of the St. Lawrence River project will do. Every time you open up new possibilities for economic growth and development you automatically create more job opportunities.

Mr. FRISCHKNECHT. That is right. We have a whole area in that upper Colorado River Basin, waiting for development—new resources, new markets for farm products, new markets for manufactured goods, new sources of labor supply.

Mr. REUTHER. That is right.

Mr. FRISCHKNECHT. Mr. Chairman, that concludes the only remarks I wish to make on behalf of Senator Watkins. We thank Mr. Reuther.

The CHAIRMAN. Mr. Moore, would you like to ask any questions?

Mr. MOORE. I wondered, Mr. Reuther, if you would have any judgment on the relative impact of automation upon the large companies in your industry as compared with the so-called independents. Is this going to work out to be a lifesaver for the independents, helping them to stay in business longer, or is it going to be an added problem, if not a coupe de grace?

Mr. REUTHER. I wish the situation were different than it is, but you are asking me to express my point of view.

I believe that automation will tend to intensify the problems of the small producers, and tend to give the larger producers a greater advantage. Automation is the key to lower unit costs and lower unit costs is the key to greater volume.

It is kind of a vicious circle you get caught in. If you are selling a car at a certain price, and if you can double the volume of the production of that car by automation, and so forth, then you get the benefits of that greater volume and the efficiency of that greater volume and you can then lower the price.

I think that inescapably—and this is true of the automotive industry, it is true of any basic industry—that the larger producer will have greater advantages out of automation that a small producer will not have access to.

Now, the small producer will have some advantages, but by and large, they will be more than offset by the sheer size and the total volume of the large producer.

Essentially that is the problem of the small automotive producers. Their problem is not labor costs. Their problem is not design. Their problem is essentially his volume. If you can get your volume up high enough, you can get your unit cost of production down to make yourself competitive. If your volume is not sufficiently high, then all the king's horses and all the king's men cannot solve the problem of high unit costs because of low volume.

The CHAIRMAN. Mr. Ensley?

Mr. ENSLEY. Mr. Reuther, when Mr. Davis, vice president of Ford, appeared on Friday afternoon, he indicated that at Ford they had more than absorbed the displaced workers resulting from new technological developments and on page 13 of his statement he said that—

> During 1954, total man-hours worked were 14 percent greater than in 1950, an increase greater than the increase in our unit production.

He indicated that they had put more man-hours in per unit than before.

Now, how would you explain that and the problem of displacement of workers accompanying such technological developments?

Mr. REUTHER. The impact of automation in the Ford Motor Co. came about essentially during a period of considerable expansion, and the increase of their production schedules. If automation had had its impact as fully in 1954, with a lower schedule of production, as they had in 1955, then it would have been a different kind of a problem.

Also, the fact that the Ford Motor Co. was getting a larger share of the total automotive markets at the expense of the independents, at the expense of Chrysler.

I think, to really measure the impact of what automation could do, you would have to measure it in a situation where everything was constant, because if you measure a point where they are expanding, obviously they can absorb the difference, and that is exactly what happened in the Ford Motor Co. But if the volume of production had remained static; if they hadn't gotten a larger share of the market, and they then had introduced automation, there is no question about it, that it would have meant unemployment. But they expanded their share of the market. They increased their volume of production and that took up the slack that automation otherwise would have created.

Mr. ENSLEY. Thank you. One more question: You mentioned the need for a clearinghouse for information on automation. I think that perhaps here is an area where the executive agencies such as the Department of Commerce, Labor, and others, could perhaps do a much better job on productivity figures, or clearinghouse of related information.

Could your staff supply us with a memorandum on the type of information they think would be most appropriate for these executive agencies to supply? Your staff has been very helpful in the past on statistical matters. Here is one that you can help us pinpoint

(The following letter was later received for the record:)

CONGRESS OF INDUSTRIAL ORGANIZATIONS,
Washington, D. C., November 9, 1955.

Hon. WRIGHT PATMAN,
Chairman, Subcommittee on Economic Stabilization,
Joint Committee on the Economic Report, Washington, D. C.

DEAR CONGRESSMAN PATMAN: This letter is in reply to a question put to CIO President Walter Reuther when he testified on automation at the hearings conducted by the Subcommittee on Economic Stabilzation of the Joint Committee on the Economic Report. At that time Mr. Reuther told the committee that the CIO staff would submit a list of some of the types of information it considers important for the joint committee staff to obtain in connection with a continuing study of the social and economic implications of the new technology.

I have discussed this matter with Nat Goldfinger and others of the CIO staff and am submitting the following suggestions as indicative of the type of information we would consider essential to such a continuing study.

We believe that the joint committee could serve as a clearinghouse for information on the social and economic impact of the spreading introduction of automation. Through annual or semiannual publications the joint committee staff could present its most recent findings on this subject and, in that way continue the work that the committee started at the hearings. Should special problems arise or appear to be developing, these staff documents could call attention to them and could advise the committee and the public at large on their nature and the possible avenues for their solution.

The basic work of developing the required information on this subject could probably best come from special and continuing studies by Government agencies and universities, which the joint committee should encourage, and, perhaps, through occasional hearings by the joint committee in selected localities.

We would be glad to discuss the following suggestions with the joint committee staff at its convenience, to clarify them, if necessary, and to discuss the scope of information that we consider essential to a continuing study of the subject.

1. Case studies

Such case studies should include the number of layoffs in the plant, by department, to reflect layoffs due directly to the installation of automation equipment or indirectly, through bumping, for example; types of workers laid off by sex, age, skill, job classification, and seniority; types of workers who have obtained new jobs in the plant, by sex, age, skill, job classification, and seniority; changes in job contents, job classifications, skills, and wage rates—including dilution of skills and wage cuts, as well as upgrading; provisions, if any, for retraining the work force; labor-management relations aspects—such as possible joint consultation in preparation for the installation of new equipment and continuing consultation to iron out problems; changes in rates of output; extent to which the new equipment is being used to fullest efficiency at the time of the study and what changes in employment, job contents, wage structures, etc., may be expected in the future as use of the equipment improves in efficiency; estimates of the cost of new equipment, rates of output, required size of work force, and wage rates, by comparison with previous type of equipment; experience of workers who obtain new jobs on new equipment, with special emphasis on the experience of older workers; experience of laid-off workers in finding new jobs, what types of jobs in relation to skills and wages, in same or different industries, in same or different communities.

Attempts should be made to engage in on-the-spot studies before, during, and after the installation of new equipment. An original case study should be followed up by further study or studies of the same plant, after a time interval, to obtain an adequate picture of the adjustment problems.

2. Industry analyses

Analyses of specific industries which are not possible from regularly published available data—such as electronics industry or the radio and television industry alone—to include the extent to which automation equipment is now operating, as well as plans for the installation of such equipment in the next several years; comparisons of employment by type (production, maintenance, supervisory, clerical) with output, over periods of time; changes in composition of work force; changes in man-hour output and in output per unit of fixed capital; changes in prices of goods produced by the industry; changing relationships among firms

in the industry—such as the effect of new equipment on the competitive advantage of individual firms; does automation in one firm or group of firms curtail output and employment in other firms; competitive position within the industry of smaller companies; changing geographic location of plants in the industry; impact on communities—to what extent are old plants in the industry closed down and new plants built in new areas and the effects on old and new communities in terms of employment, unemployment, and general living conditions.

3. Broad analyses of employment

Analyses of shifts in employment by broad industry and regional categories—which industry groups and categories are growing, which are stagnating, and which are declining; shifts in types of employment, such as hourly paid workers, skilled and unskilled production workers, maintenance, supervisory, and clerical employees.

4. Collective-bargaining provisions in relation to technological change

Studies of provisions in collective bargaining agreements in relation to the installation of new equipment—such as joint consultation provisions, company-financed retraining programs, provisions for unemployed workers, such as guaranteed wage plans, provisions for severance pay in the case of laid-off workers, and other similar provisions, with sample clauses and estimates of the extent to which such provisions exist.

5. Business investment

Studies of present and planned fixed capital investment by industry groups, in an attempt to obtain, if possible, estimates of expenditures for expanding output as distinct from replacement; expenditures for automation equipment, comparative costs of new equipment and old equipment, and comparative output of old equipment with anticipated output from new equipment; also, studies of technological changes and new machines, being introduced or planned for introduction, by industry group, for the next 3 to 5 years. Such studies should be based on studies of the capital equipment producing industries, as well as on the industries for whom the equipment is produced.

6. Education facilities

Facilities for retraining present work force in new skills; facilities for training new workers in required skills; facilities for education of professional engineers, technicians, and skilled workers, number of such facilities, instructors, and students; quality of facilities and instruction.

Sincerely yours,

STANLEY H. RUTTENBERG,
Director.

Mr. REUTHER. We should be very happy to cooperate. I am sure the staff will follow through.

I would like to point out this problem, that our experience with certain of the executive agencies of the Government has been very unsatisfactory in this respect: that they have information that we cannot get access to. We can't get figures on average wages and things like that. They tell us, "We have got this only on a confidential basis," and, "If we give it to you, the industry won't give it to us any more."

It seems to me all of the basic essential economic facts ought to be available to everyone. There should be no economic iron curtains behind which this information is hidden. It is quite agreeable for us for the executive branches of the Government to handle these matters, but they have got to change their policy so that all economic groups scan have access to the information.

Under the present situation we go over to the Department of Labor. We know that they have certain basic data because they issue reports based upon the data. All we get are the conclusions that they arrive at based upon their analysis of the data. So we say, "We don't agree with your conclusions. Can we have access to the data?" and the answer is "No." We say, "Why not? This is the people's Government; how come we can't?"

They say, "We have only got this information on the basis that it will be used confidentially within the framework of the Government operation and will not be made public."

That is the problem we have.

The clearinghouse idea is important because unless there is some governmental clearinghouse, and that group assumes the responsibility for pulling together and analyzing and making available to the public generally the total information on automation and these other new developments, then it will not be available because no private economic group has access to all of it.

Even General Motors, with all their resources, will not know what other industries are doing in this specialized field.

It seems to me that some governmental agency must perform the function of a clearinghouse to assemble, to organize, and to make available to the public the total information in this important field.

Mr. ENSLEY. That is a very interesting point, Mr. Chairman. Thank you very much, Mr. Reuther.

The CHAIRMAN. Mr. Reuther, suppose that by 1965 our population has increased to, say, 190 million people and we expand our economy during that time so as to have the maximum production and the maximum purchasing power.

What do you predict the workweek will be in hours at that time?

Mr. REUTHER. I think by 1965 we can have what I would choose, if I were making the decision, a shorter workweek, based upon four 8-hour days.

The CHAIRMAN. Four 8-hour days?

Mr. REUTHER. That is right. Then we will have leisure, and with that leisure we can use it constructively and will develop new interests, new appetites, and new employment opportunities to satisfy those new appetites.

The CHAIRMAN. I have been asked by the other members of the committee to ask you and other witnesses, if you are willing to answer questions that are submitted in writing to you, if they are submitted in time to get them back in the record to be printed. Will that be agreeable?

Mr. REUTHER. I will be happy to cooperate.

The CHAIRMAN. Are there any further questions?

(No response.)

The CHAIRMAN. Thank you very much, Mr. Reuther.

Without objection, the committee will stand in recess until tomorrow at 10 o'clock.

(Whereupon, at 12:03 p. m., the committee recessed until 10 a. m., Tuesday, October 18, 1955.)

AUTOMATION AND TECHNOLOGICAL CHANGE

TUESDAY, OCTOBER 18, 1955

Congress of the United States,
Subcommittee on Economic Stabilization of the
Joint Committee on the Economic Report,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Wright Patman (chairman) presiding.

Present: Representative Wright Patman (chairman of the committee, (presiding).

Also present: William H. Moore, staff economist, and Grover W. Ensley, staff director.

The Chairman. The subcommittee will please come to order.

Mr. Pragan, as research director for International Chemical Workers Union, you are close to an industry which is very highly automated and has indeed more or less grown up that way rather than through conversion. I hope that in your statement you will be able to tell us something about the technical skills required of the individual workers who are pictured in the magazines, watching dials on a remote control board in a chemical works.

While we are not hearing from representatives of the petroleum industry as such, I assume that many of the operational details of petroleum refining, since it, too, is a continuous-flow industry, are similar to those in the chemical field.

Mr. Pragan, we are glad to have you, and you may proceed as you desire.

STATEMENT OF OTTO PRAGAN, DIRECTOR, RESEARCH AND EDUCATION, INTERNATIONAL CHEMICAL WORKERS UNION

Mr. Pragan. Thank you very much, Mr. Chairman, on behalf of my international union and myself.

I appreciate very much this opportunity to present the views of our union on automation in our industry. From the beginning, let me say that I am not going to try to give you a definition of automation, because I am sure you have heard as many definitions as you have had people testify here, so I would rather discuss some of the problems which we face in our own industry, and leave the theoretical problems aside.

In general terms, the technology of the chemical industry has accomplished a kind of continuous automatic production, which I might say is surpassed only, if it is surpassed, by the petroleum industry, as you yourself, Mr. Chairman, already have mentioned.

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Very frequently automatic devices are used not only to combine several different processes into a single continuous process, but—and this is quite important—to derive numerous byproducts at the same time, all untouched by human hands.

I think it might be quite useful before we talk about the problems we face to say a little bit about our own industry. I think it is important, since our industry is a very complicated one, to describe. I am talking about the parts of the industry covered under the title "Chemicals and Allied Products."

Chemicals and allied products, as defined by the United States Bureau of the Census, includes three parts: First, basic chemicals, such as inorganic and organic chemicals; then chemical products, such as synthetic fibers, plasticizers, dyes, and pigments which are used as raw materials in other industries; and finally finished products such as soaps, drugs, paint, explosives, fertilizers, and vegetable oils.

The chemical industry is a very, very young industry. It grew tremendously during World War II, and we hardly had very much of a chemical industry prior to World War I. The nature of the chemical industry, its products and processes, invites extensive use of automation much more readily than many other industries.

Let me say a few words about the size of our plants. Although we are now a very large industry, employing more than 800,000 employees, the plants in the chemical industry employ relatively few workers. According to census figures for 1953, 80 percent of all establishments in the chemical industry employ less than 100 employees and only 2 percent of all plants have 500 or more employees.

However, these 2 percent employ nearly one-half of the total labor force in our industry. Nobody should get the notion that these figures mean the chemical industry is made up of small enterprises. On the contrary, in our industry eight large companies control approximately four-fifths of the total assets.

The chemical plant is much more mechanized than plants in most other industries. If we look at expenditure figures you will see that since the end of World War II, 10 percent of all expenditures for new plant and equipment in the whole country were used in the chemical industries and, as I said before, only the petroleum industry has expended a large amount.

This high level of capital investment can be traced quite clearly to the increased use of automatic machinery, development of new processes, new inventions, and new products.

I might give just a few figures to show the outlay for expenditures per production worker, which in my opinion are quite interesting. For example, in 1954 our industry spent $2,240 per production worker for new plant and equipment. This is two and a half times more than the average for all manufacturing industry, which was $877. It has been estimated that approximately 20 percent of these annual expenditures, used for new plant and equipment, go into automatic control devices.

To point up even more forcefully this high degree of mechanization in our industry, let us look at the total capital investment per production worker. In 1954 this investment amounted to $26,665, which is twice as much as the $12,933 investment per worker for all manufacturing industries. Since this figure of $26,665 which I just gave represents an average for all parts of the industry, it, of course, does not do justice to the more mechanized parts of the chemical industry.

Take, for instance, the manufacture of ammonia. It is estimated, by the Manufacturing Chemists' Association that capital investment per production worker comes to $42,500. It is an astonishing figure. It means every worker, working in an ammonia plant—the average worker, including the highest skilled and the lowest skilled, the operator and the janitor—is responsible for $42,500 worth of equipment.

The CHAIRMAN. That is four times the average, I believe.

Mr. PRAGAN. That is correct.

The CHAIRMAN. For all industries.

Mr. PRAGAN. That is very true.

This continued high rate of investment in new plant and equipment in the industry, of course, has far-reaching effects on the relationship between employment and production in our industry.

I am not going to give you all the figures which would illustrate these facts, or this relationship. The brief submitted has additional statistical data. Let me just mention that the increase in production in the overall chemical industry in the last 8 years, since the end of World War II, amounts to 53 percent, or 7½ percent per year, while in all manufacturing these figures are 25 percent, or 3½ percent per year, respectively.

If we take the two parts of the chemical industry which are most mechanized, the inorganic and the organic chemical industries, we will see that the increase in production in these two parts of the industry comes to 9 percent per year during the last 8 years.

Let us look at the employment figures and we will see a very astonishing development. During the same period, in the same period during which production has risen by 53 percent, the number of production workers has risen by 1 percent, or, to be exact, 1.3 percent—just 7,000 workers, from 525,000 o 532,000. But this is only part of the story, and I would like to dwell in a little more detail on this subject.

First, I would like to say a word of caution as to the number of hours, because I am sure that somebody might say "Well, maybe the number of hours worked per week has been increased," so let me state that in the chemical industry, in 1947, the number of hours worked was 41.5 hours, and in 1954, 41.1 hours. Therefore, practically unchanged.

In the inorganic chemical and in the organic chemical industries, we see exactly the same picture. In 1947, the average workweek in the inorganic chemical industry was 40.3 hours; in 1954, 40.8 hours. In the organic chemical industry, these 2 figures are 40.3 hours for 1947 and in 1954, 40.6 hours. So, for all practical purposes we can omit here any discussion of changes in the workweek.

As I said, chemical output grew by more than 50 percent, and the number of production workers remained practically unchanged, having increased by only 7,000.

Now, let us look at the number of nonproduction workers. That is a very interesting story as you will see. Nonproduction workers include professional, supervisory, clerical, and sales personnel. You

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will see that during the same period in which the number of production workers remained unchanged, or practically unchanged, the number of nonproduction workers increased by more than 50 percent. Here we really have automation in a nutshell, so to speak.

To give you 2 figures—because I think these 2 figures, Mr. Chairman, are most significant for our discussion, and I hope you will excuse me if I use so many figures here—the number of nonproduction workers rose from 169,000 in 1947, to 259,000 in 1954. That means in 1954, in the overall chemical industry, there were two production workers to each nonproduction worker. I do not think there is any industry which can compare with this ratio. In 1947 this ratio was only 3 to 1.

If we look at the inorganic and organic chemical industry, we see—and, as I said before, these 2 parts are the most mechanized parts in our industry—that in the inorganic chemical industry the number of nonproduction workers increased by 70 percent since 1947, and in the organic chemical industry it has doubled.

Mr. MOORE. I wondered whether the term "nonproduction workers" included the maintenance people.

Mr. PRAGAN. No. Maintenance people are included as production workers. Nonproduction workers are professional people, like engineers and chemists, and supervisory personnel, plant managers, foremen, and clerical people.

Mr. MOORE. What would the production workers include?

Mr. PRAGAN. Production worker means anybody who is engaged in the production process, which includes the skilled, semiskilled, and unskilled people.

I come to this a little later, because you will see that the number of unskilled people is decreasing in the chemical industry, although the number of production workers has remained pretty much unchanged. The composition of the production worker force has changed tremendously. Right now, when we compare nonproduction and production workers, we are talking about the people directly engaged in the production process as compared with the people who are not directly engaged in the production process.

As I said, it might be interesting to the committee to compare this development or this ratio between nonproduction people and production workers in the chemical industry, with similar figures for all manufacturing industries, and you will see that, taking the average for all manufacturing industries, including, of course, the chemical industry here, that this increase is approximately 27 percent. It means 27 percent is the increase of nonproduction workers during the last 8 years in all manufacturing industries.

I would submit that these factors show clearly the phenomenal rise in chemical output per man-hour and thus indicate the extent to which automatic production has gained a very firm foothold in our industry.

Let me say a few words about our processes.

As I said before, production in the chemical industry lends itself very readily to the use of automatic devices. As a rule the production process in the chemical industry is continuous. You could call it even a continuous-flow process, operating 7 days a week, and 24 hours a day. It is mass production, but not through an assembly line.

Often processing is performed in large chemical reactors, fractionating towers, and other installations which are largely regulated by automatic control devices. Continuous processing methods, with the aid of controlling devices, make it possible—and this is a very important and a very typical process in the chemical industry—make it possible in a single operation to combine, or to separate several different chemicals in order to derive one or more end products, as the case may be.

This frequently permits production of large quantities of chemicals, with only a handful of production workers.

For instance, a recently built plant in the compressed-gas industry employs only two production workers. It is the most astonishing development, at least as far as I have seen in our industry, operated with just two production workers. Well, I hope the committee will not ask me if we have a closed shop in this plant, because I would have to report that this plant is not organized.

In addition, operations in some branches of the chemical industry that are concerned with testing, filling, inspecting, and packaging after the product has come from the production line, also use automatic equipment. This is particularly the case in the soap, drug, and pharmaceutical industries.

As one writer described the chemical industry, we have complete automation in some plants, from the input of raw materials to the output of the finished product.

The ability to produce chemicals in large volume, of course, reduces the unit costs considerably, since the number of production workers need not vary directly with changes in the volume of production, as in the case of many other industries. Therefore, output can be substantially increased without any increase in the number of production workers.

That means, now, practically speaking, from the point of managing such a plant, or from the point of a union, that labor costs, relatively, are a small part in the chemical industry, and that has come about to a great extent because of the highly mechanized automatic processes.

I would like to describe the job content of a few job classifications in our industry. Take the production workers.

The chemical operators are the largest occupational group among the production workers. Their jobs include working with equipment which controls temperature, pressure, flow and levels of liquids and gases, and reaction time.

Other operator classifications include stillmen, who operate distillation equipment; driers, whose function it is to separate waters from solids; batch makers, who operate mixing machines; and millers, who operate pulverizing equipment.

The predominance of automatic equipment and other complex machinery in the industry makes maintenance skills, such as machinists, pipefitters, electricians, and instrument men—a new classification, by the way—particularly important. For this reason, the ratio of maintenance workers to production workers is greater in the chemical industry than in most other industries.

Although detailed data are not available, we have estimated that some plants employ as many as 1 maintenance employee to every 2 production workers.

I think, Mr. Moore, that is the answer to the question you asked previously.

I would like to say a few words about the problems we face in collective bargaining arising out of automation.

It is quite obvious that automation affects the skills, job security, earnings, and working conditions of the employees. Therefore it is ever present at the collective-bargaining table. Adjusting the content of the collective-bargaining agreement to the changes caused by automatic production methods is a most important responsibility of management and labor.

I might add here that our international union has developed educational programs for their own officers in the techniques of collective bargaining. One of the important approaches to teaching automation is to make our union officers alert to the changes which are going on, or which will occur in our industry, so they will be able to adopt the provisions of our collective bargaining agreements to the changed situation.

This may not appear very important to many people who are not directly involved in the collective bargaining process, but to me it is one of the most important approaches to this problem of automation. Automation is not only a problem for the top level, or for legislation, it is a problem to be attacked on the plant level as well—across the bargaining table when we negotiate a local collective bargaining agreement.

To me this is a most important aspect that is sometimes overlooked by both management and labor representatives.

Of the many collective bargaining problems we face, let me just mention a few:

First, there is the matter of scheduling of work. Continuous operations mean rotating shifts, and split workweeks. It means working daytime hours one week and nighttime the next. It means working on Saturday and Sunday as regular days of work, and on the day of rotating shift, of changing shifts, the employee might work 2 full, 8-hour shifts within 24 hours.

The inconvenience caused by this irregular work schedule must be alleviated by special premium payments, such as Saturday and Sunday premiums, even if these days are not the employee's sixth and seventh days of work. Presently such practices are an exception, and Saturday and Sunday premiums are paid only if these days are the sixth and seventh days of work.

Next, there is the question of layoffs. I am not talking about layoffs as a national problem. I am talking about layoffs as a plant problem. How do we protect employees whose jobs are eliminated because of technological changes? Through shortening the workweek? Through a form of guaranteed employment plan? Through termination or conversion pay? These are the questions for collective bargaining, and the answers of course differ from industry to industry.

Let me add, it is quite possible that the final solution here may require some kind of legislative action, but I am not going into this at this time.

A third problem is the problem of changing skills. New production processes created by automation make obsolete machinery and skills developed over many years. A machine can be discarded. The worker has to be retrained.

Retraining employees to acquire new skills has in some instances already become a subject of collective bargaining, and will receive even more attention as the need becomes more acute.

For instance, in some of our plants we have set up certain programs, 1-year, 2-year, 3-year programs, where people whose jobs are abolished are being retrained. We have done it in some plants in the Ohio Valley and some plants on the west coast, and these programs work out quite well.

Let me say, it works out well only if we find the understanding and patience necessary on the part of both union and management.

Management and unions can do much to meet this problem but here again Government action at all levels, municipal, State, and Federal, may be required to provide the necessary adjustments in our present vocational training programs.

Closely related to this matter of elimination of jobs is the newly observed trend toward combining two or more jobs.

For instance, in our industry, we see in several plants the job of the welder being combined with the job of the pipefitter, or the job of the electrician being combined with the job of the instrument man.

Now, the new classification does not mean that the man has acquired formal apprenticeship training in his combined job. Shall he get a higher job rate? What shall be his standing in his department?

Existing job evaluation systems will have to be thoroughly revised to cope with this problem as well as with the problem of completely new jobs resulting from automation.

For instance, very often the job of an instrument man is a completely new job, and in many plants we have, for instance, promotion to instrument man without having a description of the job.

There is no doubt that increased job content and responsibility require higher pay.

Another area of the labor contract that will require serious consideration is the seniority clause. The threat of elimination of entire departments or jobs through automation may make unworkable seniority systems which are based on department or job seniority and may lead to broader-based seniority systems. The relative weight given to seniority and ability in cases of promotion also needs to be reexamined. The new job, the higher paid job, may be more complex, but the seniority system must assure the senior employee the opportunity to qualify for the higher-paying job. He must not be passed over—and the job given to an outsider or to a less senior employee—simply because of age or of the disinclination of the employer to provide the training which would enable him to qualify for the job.

What we do here is, as I mentioned before, provide for training periods or trial periods in which the employee who bids for the higher paid job can prove he is qualified to work on this higher paid job.

These are only a few of the more important collective bargaining issues stemming from automation which the International Chemical Workers Union has faced or expects to face in negotiations.

Although there may be differences in degree, other unions will face the same problems as automation takes roots and develops in their industries.

In closing I would like to be permitted a few remarks as to more general implications of automation.

First, I would like to state that our union regards automation as another step in the technological development of our economy. We should not forget that what we now call automatic technology has been developed gradually, taking on different forms in the different industries.

In the chemical industry, automatic machinery and continuous processing equipment were known long before World War II. However, the advent of automatic control systems and electronic computers after the war opened a new chapter in the technological development or progress of American industry.

We see two real problems: First, the need for adequate employment and job opportunities for all, together with a fair distribution of the increased productivity—which, after all, is the ultimate goal of automation—and, second, the need to protect the rights and the position of the individual employee in the plant.

I always come back to the position of the individual employee in the plant.

To maintain full employment and to benefit from this accelerated productivity, we have to be concerned more so than ever in the past with the problems of distribution of income and of purchasing power. The purchasing power of all segments in our economy will have to match our ability to produce which is being stepped up so much by automatic production methods. If we should fail to accomplish this, either by raising the income levels of all consumers, or by keeping prices at an appropriate level, automation might become an aggravating factor in case of unemployment and economic dislocation. But even then the fault will not lie with automation as such but with our own inability to adjust our economic thinking to the new levels of technological development.

The threat of unemployment exists whenever there is technological change. To prevent the threat from becoming a reality in this case, we must anticipate the need for such measures as a shorter workweek, higher minimum wages, increased unemployment compensation, expansion of new industries, intensified research programs, and public programs for roads, schools, housing, and hospitals, but, above all, we should not overlook the fact that at all times, planning on the plant and company basis provides the first line of defense against unemployment.

Therefore, in conclusion, I would like again to stress that for our international union, the human being, the employee, is so very important. In the final analysis the individual worker is the one who will be most intimately affected by this enormous development, and it should be with this in mind that we should approach any solution to cope with the problem of automatic technology.

Thank you very much.

The CHAIRMAN. You have presented a fine, comprehensive statement. In the last few paragraphs I think you really focused our attention on problems facing us concerning industry generally, involving of course full employment and the purchasing power of the people.

I was amazed to learn that in your industry, the average cost of plant—the cost of the plant per worker—is about $43,000, which is about 4 times the average for all industry. I believe all industry is about $13,000; is it not? Evidently your industry is one that has taken hold of automation, and it is showing up more quickly in your industry.

Mr. PRAGAN. Before the word was ever invented.

The CHAIRMAN. Now then, since the chemical industry is relatively young and has grown up since the war, do you have any problems of dropping or not hiring men over 45 years of age?

Mr. PRAGAN. Absolutely. That is our problem now. It is almost impossible to find a job as a skilled operator if you are, let's say, 40 or 45 years of age. It is a question of pension plans, and lowering the age of retirement is a very important one. We would say it is not so very important now to immediately change the normal retirement age from 65 to 60, but to make it possible for an employee to retire, what we call at an earlier retirement age, or let's say at a reduced pension income, but still sufficient so that it will be a stimulus for people to retire at an earlier age. We have this problem of older people, absolutely, in our industry.

The CHAIRMAN. Do you have in mind what this early age would be?

Mr. PRAGAN. We now, in our pension negotiations, suggest 55 years of age.

The CHAIRMAN. Do you contemplate from what you have just said that the worker will not only draw this pay, which evidently will be much smaller than for the older workers, but he will also be privileged to work at other work?

Mr. PRAGAN. On some jobs which might give him smaller earnings, smaller income, but it would be additional income to his pension.

The CHAIRMAN. That still leaves what you might call a hiatus from ages 45 to 55. What is going to happen to those fellows?

Mr. PRAGAN. Here what we have to do is to retrain our people so they will have the skills to get a job, although their age may make it difficult for them to find a job. Since this cannot be done on a plant level, it should be done on a community level, or with the help of State or Federal legislation. Our vocational training program, in my opinion, should be changed to make it possible that these people could acquire new skills. If you look today at our vocational training program, very few skills are taught, which enable the workers to change from one job to another. We have to revamp, to change our vocational training program. We have a great need for it, and I think here the impetus has to come from Government agencies, from legislation, and from our schools.

The CHAIRMAN. Looking to the future, let us say 1965, it seems to be pretty well agreed that we will have a population of about 190 million people instead of our 165 million now. Suppose that our economy keeps on growing, from 3 to 5 percent a year, which most economists seem to think it will, what do you think the workweek will be at that time in hours?

Mr. PRAGAN. In 1965 I am quite sure it will be 35 hours a week.

The CHAIRMAN. As compared to 40 hours a week now?

Mr. PRAGAN. Yes, sir.

The CHAIRMAN. Would you like to make a statement, Mr. Frischknecht?

Mr. FRISCHKNECHT. Mr. Chairman, I might begin by apprising the witness of the fact that Senator Watkins from Utah, who is a member of this committee, is unable to be present, and I am Mr. Reed Frischknecht, secretary and consultant to the Senator.

The Senate has asked me to appear at the hearing here; through the courtesy of the chairman of the committee, I have been permitted to ask some questions which the Senator would ask if he were able to be present, so with that little explanation to you personally, there are a few questions I would like to ask.

Is it a fair statement to say that from the figures you presented on pages 4, 5, and 6 of your statement, that automation, or perhaps the general demand for chemicals, has created new jobs for nonproductive workers? That is, for workers outside of those that your union represents? Is that a fair statement?

Mr. PRAGAN. It is a fair statement that automation has created jobs in the nonproduction labor force.

Mr. FRISCHKNECHT. By that you meant primarily the clerical and maintenance workers, and so forth?

Mr. PRAGAN. That is right, but I would like to add that these people who are added to the nonproduction labor force have not come out of the production labor force. The only people who are added to the nonproduction labor force coming out from production, out of the production part of the labor force, are foremen, or supervisors.

Mr. FRISCHKNECHT. I understand that. We have had a total increase in the employment in the chemical industry, have we not?

Mr. PRAGAN. That is right. The total increase in the chemical industry is approximately, I would say, 100,000 over this period of 8 years.

Mr. FRISCHKNECHT. Now——

Mr. PRAGAN. 106,000.

Mr. FRISCHKNECHT. Isn't it true also that historically labor costs have always been a small part of the total costs in the chemical industry?

Mr. PRAGAN. That is right; comparatively speaking.

Mr. FRISCHKNECHT. So this thing we call automation, or the use of continuous processing devices, is nothing new in this industry, is it—the use of continuous processes is not new?

Mr. PRAGAN. That is right.

Mr. FRISCHKNECHT. Now then, actually, as far as automation is concerned, in the light of the figures you have given us here this morning, with respect to production workers, what we might anticipate in the future in the way of lesser requirements for production workers seems not to be too great. In other words, their ability to increase the continuous processing of chemicals, would seem not to lend itself to continued reductions, and reduction in the number of employees.

You mentioned, for example, 1 gas plant where there were 2 productive employees now involved in the manufacturing process. Would you think that in the future the possibility exists that these two might go by the board?

Mr. PRAGAN. Pardon me, sir. I would like to be careful here. There is one figure I might add to the many figures I already mentioned that is quite interesting.

In our industry, 77 percent of the amount spent every year for expenditures of plant and equipment, go into new plants. It means it is part of an expansion program. Either it is a new plant or it is an addition to a present plant.

Mr. FRISCHKNECHT. That is true, and I think the members of the committee understand that.

As the demand for chemicals has increased, so has our capacity to produce chemicals.

Mr. PRAGAN. If this expansion program should come to a standstill, or be much smaller, then the danger of unemployment in the chemical industry is a great one.

Mr. FRISCHKNECHT. There are possibilities perhaps for further reductions in production workers, or the number of production workers, but isn't it decreasing; isn't the possibility of there being fewer going to perhaps increase, but at a decreasing rate? In other words, it appears to me that you are not going to lose those two production workers you have got at your compressed-gas plant; isn't that correct?

Mr. PRAGAN. This is correct. Maybe I should not have used this example of two people.

Mr. FRISCHKNECHT. In other words, maybe we are reaching the point of diminishing return here as far as this industry is concerned?

Mr. PRAGAN. I don't think so. What is going to happen here is, if we didn't have these automatic devices in our chemical industry, say the number of production workers would not be 530,000 but maybe 600,000 or 730,000. It means we would hav eattracted many, many more people in our industry. We have not done it.

Mr. FRISCHKNECHT. There is one thing we have to take into consideration here: That the manufacturing processes in chemicals have always been of a highly technical nature.

Mr. PRAGAN. That is right.

Mr. FRISCHKNECHT. In which mechanical equipment or automatic equipment or the distillation processes themselves have always required fewer employees than most other manufacturing industries.

Mr. PRAGAN. Certainly.

Mr. FRISCHKNECHT. That is why I asked you if it wasn't true that historically that the percentage of labor costs as they relate to total costs in this industry, were relatively low, were relatively smaller than in most industries.

Mr. PRAGAN. That is true.

Mr. FRISCHKNECHT. I was interested in some of the remarks you made with respect to some items that might, or already have, become questions which affect the bargaining process, which the collective bargaining process has attempted to handle. You mentioned this matter of the scheduling of work. Of course I was drawn immediately back to the illustration you used of the compressed gas plant, where you indicated that only two production workers were involved. I was wondering what kind of supermen you have there. Do those men get a weekend off once in a while or do they work alternately 12 hours or is the process such that those individuals can be away from the plants for long periods of time? That was just a little thought that came to mind.

Mr. PRAGAN. That is a very good question.

Mr. FRISCHKNECHT. Perhaps maybe the union needs to take a look at the best interests of those two workers.

Mr. PRAGAN. We have to organize them first.

The CHAIRMAN. Are those plants actually—is that plant actually in operation?

Mr. Pragan. It is in operation now.

Mr. Frischknecht. This matter of retraining——

Mr. Pragan. May I make a remark about the plant with the two production workers?

Mr. Frischknecht. I realize why you made the illustration. We don't want to take it out of the context you put it in.

This matter of retraining of production employees: I presume your remarks here are directed in their behalf. Don't we have some individual responsibility on the part of people to kind of protect their own best interests, keep themselves apprised of what the employment outlook might be as a result of new innovations in their industry. I imagine lots of blacksmiths some 25 or 30 years ago began to think of becoming auto mechanics, and so forth. Don't we have a corresponding responsibility of people here? This leads into another question. You mentioned something about the matter of retraining and scheduling the workers, as requiring some legislation. I presume that should be here by the Congress. I am just wondering—and I know Senator Watkins would be interested in knowing what the union itself has done in the way of providing training programs for their own members. These union members pay dues, and so forth. What type of services have they been able to get out of the union in terms of a training program?

Mr. Pragan. May I say a few words in replying to your question?

Mr. Frischknecht. Yes, sir.

Mr. Pragan. I do not think a union can solve the problem. What we can do is to talk about it and do something about it through collective bargaining. Let me tell you, for instance, about one plant, what we do.

No international union or no local union is equipped to retrain people. It shouldn't. That is not their job, but what we should be aware of, and what we do is to negotiate into the contract with a company a provision whereby people are trained in the certain skills, at their own time.

Take a pipefitter. In one plant we have an agreement where the pipefitter has the opportunity to learn the maintenance of certain new control devices, by going to a course set up by the school system in his community. He is doing it on his own, after work, but that is all really a union can do.

To believe that we can set up such courses and really relieve the situation, I think, would be a dream. It would not be fair for my union to make such a suggestion because I am sure the union cannot do it.

However, what we can do, and that is the reason I talk about the situation, is to change our apprenticeship setup, which is old fashioned now.

Mr. Frischknecht. This is the union apprentice setup you are speaking of?

Mr. Pragan. No. We are an industrial union. We are not a craft union. That means we are taking in, not only——

Mr. Frischknecht. Is yours a CIO affiliate?

Mr. Pragan. Our union is affiliated with the AFL. As I said, government, for instance, on a local level or the school system, together with the apprenticeship bureau, with the union movement, might set up new requirements, new courses, and find new resources to make it possible for people who might be laid off.

Mr. **Frischknecht**. We have all kinds of adult education classes sponsored by local boards of education, by our high schools, extension sources by our colleges, and State vocational schools.

Mr. **Pragan**. It will never do.

Mr. **Frischknecht**. We do it in Utah.

Mr. **Pragan**. We have them in Ohio, too, but that will never give a man technical skills he needs in order to make a living.

Mr. **Frischknecht**. Perhaps this is a subjective matter of opinion, and I do not wish to quibble with you, except to say that there is a large body of informed opinion that believes the effectiveness of the adult education opportunities I have mentioned is relatively good.

Now, the point I want to make here, perhaps this is in part a community problem; perhaps it is partly a union problem, but it isn't always all the employer's responsibility, is it?

Mr. **Pragan**. No. I didn't say it is only the employer's responsibility.

Mr. **Frischknecht**. I didn't imply you said that. I was merely asking what your opinion was.

Is this in your opinion and in the opinion of your union entirely the responsibility of the employer?

Mr. **Pragan**. No. It is also the responsibility of the union and it is also the responsibility of the community, and of Government agencies.

Mr. **Frischknecht**. I think Senator Watkins would agree with you, that here we have a number of very interested parties, who have a concern and ought to have a concern about what happens to these displaced people. But, I think the Senator would insist that it is a responsibility that involves a number of parties, not just the employer.

Mr. **Pragan**. I agree.

May I say one word? I agree entirely with what you said. In fact, I mentioned it before. When I talked about labor and management, I didn't mean here alone, the local union labor leadership in a particular plant. I am talking here about labor and management from a higher level.

Mr. **Frischknecht**. And of course I want you to understand that my only purpose in being here this morning on behalf of Senator Watkins is to get some information into the record which will give the members of this committee an opportunity to understand all of the facts and all of the ramifications of automation.

I am not here, and I am not asking these questions for the purpose of trying to represent more one interest than another.

I might add that Senator Watkins has very fine relationships with the CIO in the State of Utah. We have some very fine labor leaders in that State.

Mr. **Pragan**. I understand fully.

Mr. **Frischknecht**. Now, the matter of seniority and superannuation of employees. You mentioned the individuals displaced who are 45 years of age or over. Isn't that a general problem that almost all people of that age face, if they lose a job? As we grow older, of course, our usefulness, our potential usefulness to an employer is less. We have a fewer number of good productive years left. I think this is no less true of production workers in the chemical industry than it is of politicians who have reached the upper years of their life span. It is no less true of schoolteachers who lose a job, or of Government employees or any other professional group of people. Isn't that true?

Mr. PRAGAN. Pardon me. It is not quite the same, because the age element is only one of the problems.

Mr. FRISCHKNECHT. I realize that. You were speaking here of the age factor and you used the age 45. And, of course, I think that factor applies to practically all people who lose a position.

Mr. PRAGAN. The seniority problem is not only a problem of age. What we are really now facing is the following problem: Let's say somebody got a better job and he is only 40, and here is an opening. His job was a very specialized job. It was a job where he got some special training to take care of automatic equipment and now our present seniority system does not make it possible that this job be filled according to seniority. The man who would get it under different circumstances might be maybe 30 or 35 years of age, because in the chemical industry, as in many other highly technical industries, promotion is mostly done by the way of job seniority, or job classification, or departmental seniority.

Mr. FRISCHKNECHT. Mr. Pragan, I want to thank you very much on behalf of Senator Watkins for your very fine and very able and comprehensive statement.

I am particularly impressed with the objectivity that you exhibited in your statement and your answers to questions this morning.

Thank you very much.

Mr. PRAGAN. Thank you.

The CHAIRMAN. I assume that you will be willing to answer any questions any member of the committee wants to ask you between now and the time the record closes?

Mr. PRAGAN. Yes, sir.

The CHAIRMAN. Thank you very much for your appearance and for your contribution.

Mr. PRAGAN. Thank you very much. Our union appreciates very much the opportunity to appear here.

(The prepared statement of Mr. Pragan follows:)

STATEMENT OF OTTO PRAGAN, DIRECTOR, RESEARCH AND EDUCATION, INTERNATIONAL CHEMICAL WORKERS UNION

I appreciate this opportunity to present the views of the International Chemical Workers Union on automation in the chemical industry. We are very glad that this committee has undertaken a study on automation and technological change because this problem affects the welfare of the members of our union.

I

There are as many definitions of the term "automation"—or, as I prefer, "automatic technology"—as the number of books, articles, and treaties that have been written on this subject. I am sure this committee has heard a few more.

It is not very meaningful for the purpose of this hearing to define automation in a general way because its application differs widely from industry to industry. It is well to remember, as one writer has already noted, that automation is relative and not absolute. What many people today describe as automation in other industries has for years been common practice in the chemical industry.

In general, the technology of the chemical industry has accomplished a form of continuous automatic production which is probably surpassed only by the oil-refining industry. Frequently, automatic devices are used not only to combine several different processes into a single continuous process, but to derive numerous byproducts as well, all untouched by human hands.

II

For our purposes it will be useful to have a clear picture of the nature of the chemical industry. In reality, it is a combination of many different industries. "Chemicals and allied products," as defined by the Bureau of the Census, includes basic chemicals such as inorganic and organic chemicals, chemical products such as synthetic fibers, plasticizers, dyes, and pigments used as raw materials in other industries, and, finally, finished products such as soaps, drugs, paints, explosives, fertilizers, and vegetable oils.

The "chemical industry," which is the term used to describe the various industries in the chemical field which were mentioned previously, is a relatively young industry. It is the fastest-growing industry in our economy and ranks sixth in volume of sales among the manufacturing industries.

The nature of the industry, its products, and processes, invites the extensive use of automatic technology more readily than many other industries.

III

Characteristically, plants in the chemical industry employ relatively few workers. The plants, however, are quite numerous. According to Census figures for 1953, 80 percent of all establishments in the chemical industry employ fewer than 100 workers. Only 2 percent of all plants have 500 or more employees. However, these 2 percent employ nearly one-half of the total labor force in the industry. These figures do not mean that the chemical industry is made up of so-called small enterprises. On the contrary, it is an industry in which eight large companies control approximately four-fifths of total assets in the industry.

Next, one finds in the chemical plant much more mechanized equipment than in most plants of other industries. Since the end of World War II, 10 percent of all expenditures for new plant and equipment were in the chemical industry. Only the petroleum industry expended a larger amount.

This high level of capital investment can be traced to the increased use of automatic machinery, the development of new processes, new inventions, and new products. The amount of this outlay can be best expressed in terms of expenditures per production worker. For example, in 1954 the industry spent $2,124 per production worker for new plant and equipment. The average for all manufacturing was $877. It has been estimated that approximately 20 percent of the annual expenditures for new plant and equipment goes into automatic-control devices.

To point up even more forcefully the high degree of mechanization in the chemical industry, we need only look at the total capital investment per production worker. In 1954 this investment amounted to $26,665—more than twice the $12,933 investment per worker for all manufacturing. Since the figure for the chemical industry is an average for all parts of the industry, the per worker investment is, of course, far greater in the parts where automation is well advanced. For instance, it has been estimated by the Manufacturing Chemists' Association that capital investment per production worker in the manufacture of ammonia is $42,500.

This continued high rate of investment in new plant and equipment in the industry has had far-reaching effects on the relationship between employment and production, as can be readily seen from the following tables:

TABLE 1.—*Industrial production index*

[1947-49 average equals 100]

Year	All manufacturing	Chemicals and allied products		
		Total	Inorganic chemicals	Organic chemicals
1947	100	97	96	94
1948	103	103	101	106
1949	97	101	103	100
1950	113	121	120	128
1951	121	136	135	149
1952	125	137	137	141
1953	134	147	149	155
1954	125	148	157	152

Source: Federal Reserve Board.

TABLE 2.—*Employment in all manufacturing and in chemical industry*

[In thousands]

Year	All manufacturing		Chemicals and allied products					
			Total		Inorganic		Organic	
	All employees	Production workers	All employees	Production workers	All employees	Production workers	All employees	Production workers
1947	15, 290	12, 795	694	525	72	55	227	180
1948	15, 321	12, 715	700	522	75	56	234	183
1949	14, 178	11, 597	663	484	72	53	216	164
1950	14, 967	12, 317	682	494	73	53	229	173
1951	16, 104	13, 155	749	536	83	60	265	198
1952	16, 334	13, 144	770	537	87	62	283	204
1953	17, 238	13, 833	807	553	94	67	317	222
1954	15, 989	12, 588	791	532	101	72	299	204

Source: U. S. Bureau of Labor Statistics.

These tables indicate that the substantial increase in chemical output since 1947 has come about without any significant increase in the number of production workers and, therefore, is traceable to automatic production methods. In this connection it is important to note that over this period the average workweek in the chemical industry remained practically unchanged: all chemicals, 1947, 41.5 hours; 1954, 41.1 hours; inorganic chemicals, 1947, 40.3 hours; 1954, 40.8 hours; organic chemicals, 1947, 40.3 hours; 1954, 40.6 hours.

While growth of production in all manufacturing during the period 1947–54 was 25 percent, or 3½ percent per year, production in the chemical industry increased by 53 percent, or 7½ percent per year. During the same period the increase in production of inorganic and organic chemicals came to an average of 9 percent per year.

While chemical output rose by more than 50 percent, the number of production workers remained practically unchanged, having increased by only 7,000, that is, 1.3 percent. But the number of nonproduction workers, that is professional, supervisory, clerical and sales personnel, increased by more than 50 percent—from 169,000 in 1947 to 259,000 in 1954. Thus, in 1954 there were two production workers to each nonproduction worker, while in 1947 the ratio was as high as 3 to 1. This increase in nonproduction employment also is partly traceable to automatic production methods.

The influence of automatic production equipment becomes even more obvious in inorganic chemicals where the number of nonproduction workers increased by 70 percent since 1947, and in organic chemicals where the number of nonproduction workers doubled.

In contrast with the more-than-50-percent gain in nonproduction workers in the chemical industry, the net gain in all manufacturing during this period was 27 percent.

These factors show clearly the phenomenal rise in chemical output per man-hour and thus indicate the extent to which automatic production has gained a firm foothold in the industry.

IV

Production in the chemical industry lends itself readily to the use of automatic devices. As a rule, the production process is a continuous one, operating 7 days a week and 24 hours a day. It is mass production—not through an assembly line—but by means of a continuous, automatic process. Often, manufacturing is performed in large chemical reactors, fractionating towers and other installations which are largely regulated by automatic control devices.

Continuous processing methods with the aid of controlling devices make it possible in a single operation to combine or to separate several different chemicals in order to derive one or more end products, as the case may be. This frequently permits production of large quantities of chemicals with only a handful of production workers. For instance, a recently built plant in the compressed gas industry employs only two production workers. In addition, operations in some branches of the chemical industry that are concerned with testing, filling, inspecting and packaging, after the product has come from the production line, also use automatic equipment. This is particularly the case in the soap, drug and pharmaceutical industries.

Ability to produce chemicals in large volume reduces unit costs considerably since the number of production workers need not vary directly with changes in the volume of production as in the case of many other industries. Therefore, output can be substantially increased without any increase in the number of production workers.

Among production workers in the industry, chemical operators are the largest occupational group. Their jobs include working with equipment which controls temperature, pressure, flow and levels of liquids and gases, and reaction time. Other operator classifications include stillmen, who operate distillation equipment; driers, whose function is to separate waters from solids; batch makers, who operate mixing machines; and millers, who operate pulverizing equipment.

The predominance of automatic equipment and other complex machinery in the industry makes maintenance skills, such as machinists, pipefitters, electricians, instrument men, etc., particularly important. For this reason, the ratio of maintenance workers to production workers is greater in the chemical industry than in most other industries. Although detailed data are not available, some plants employ as many as 1 maintenance employee for every 2 production workers.

V

It is quite obvious that automation affects the skills, job security, earnings and working conditions of the employees. It is ever present at the collective bargaining table. Adjusting the content of the collective bargaining agreement to the changes caused by automatic production methods is a most important responsibility of management and labor.

In this connection, I would like to point out some of the problems we face in the chemical industry.

First, there is the matter of scheduling of work. Continuous operations mean rotating shifts and split workweeks. It means working daytime hours one week and nighttime the next. It means working on Saturday and Sunday as regular days of work. And on the day of rotating shift, the employee might work two full 8-hour shifts within 24 hours.

The inconvenience caused by this irregular work schedule must be alleviated by special premium payments, such as Saturday and Sunday premiums even if these days are not the employee's sixth and seventh days of work. Presently, such practices are an exception and Saturday and Sunday premiums are paid only if these days are the sixth and seventh days of work.

Next, there is the question of layoffs. How do we protect employees whose jobs are eliminated because of technological changes? Through shortening the workweek? Through a form of a guaranteed employment plan? Through termination or conversion pay? These will be questions for collective bargaining and the answers may differ from industry to industry. However, it is quite possible that the final solution to this problem may require legislative action.

Also to be considered is the problem of changing skills. New production processes created by automation make obsolete machinery and skills developed over many years. The machine can be discarded. The worker has to be retrained.

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Retraining employees to acquire new skills has in some instances already become a subject of collective bargaining and will receive even more attention as the need becomes more acute. Management and labor can do much to meet this problem but, here again, Government action on all levels may be required to provide the necessary adjustments in our present vocational training programs.

Closely related to this matter of elimination of jobs is the newly observed trend toward combining two or more jobs, such as welder and pipefitter, and instrument man and electrician. Existing job evaluation systems will have to be thoroughly revised to cope with this problem, as well as with the problem of completely new jobs resulting from automation. There is no doubt that increased job content and responsibilities require higher pay.

Another area of the labor contract that will require serious consideration is the seniority clause. The threat of elimination of entire departments or jobs through automation may make unworkable seniority systems which are based on department or job seniority and may lead to broader-based seniority systems. Similarly, the relative weight given to seniority and ability in cases of promotion needs to be reexamined. The new job may be more complex, but the seniority system must assure the senior employee the opportunity to qualify for the higher paying job. He must not be passed over—and the job given to an outsider or to a less senior employee—simply because of age or the disinclination of the employer to provide the training which would enable him to qualify for the job.

These are only a few of the more important collective-bargaining issues stemming from automation which the International Chemical Workers Union has faced or expects to face. Although there may be differences in degree, other unions will face the same problems as automation takes roots and develops in their industries.

VI

Turning to the more general implications of automation, I should state that our union regards automation as another step in the technological development of our economy. We should not forget that what we now call automatic technology has been developed gradually, taking on different forms in the different industries. In the chemical industry automatic machinery and continuous processing equipment were known long before World War II. However, the advent of automatic control systems and electronic computers after the war opened a new chapter in the technological progress of American industry.

Labor sees two real problems: first, the need for adequate employment and job opportunities for all, together with a fair distribution of the increased productivity—which, after all, is the ultimate goal of automation—and, second, the need to protect the rights and the position of the individual employee in the plant.

To maintain full employment and to benefit from this accelerated productivity we have to be concerned, more so than ever in the past, with the problems of distribution of income and of purchasing power. The purchasing power of all segments in our economy will have to match our ability to produce which is being stepped up so much by automatic production methods. If we should fail to accomplish this, either by raising the income levels of all consumers or by keeping prices at an appropriate level, automation might become an aggravating factor in case of unemployment and economic dislocation. But, even then, the fault will not lie with automation, as such, but with our own inability to adjust our economic thinking to the new levels of technological development.

The threat of unemployment exists whenever there is technological change. To prevent the threat from becoming a reality in this case, we must anticipate the need for such measures as a shorter workweek, higher minimum wages, increased unemployment compensation, expansion of new industries, intensified research programs, and public programs for roads, schools, housing, and hospitals. But, above all, we should not overlook the fact that at all times planning on the plant and company basis provides the first line of defense against unemployment.

In conclusion, let us return to the individual—the human being. In the final analysis, he is the one who will be most intimately affected by this enormous development that so many envisage. It should be with this in mind—the human use of human beings (to borrow a phrase from Norbert Weiner)—that we should approach any solution to cope with the problem of automatic technology.

The CHAIRMAN. Our next witness will be Mr. Don G. Mitchell, chairman and president, Sylvania Electric Products, Inc.

Mr. Mitchell, you have been referred to by Business Week as a vocal exponent of decentralization. Your company, I understand, has some 53 plants and warehouses, and that as a result your company, Sylvania, is a highly decentralized operation, both physically and in the way it is managed.

We are interested in your philosophy and thinking on this score. What will be the effect of automation on decentralization, since you are the first of our witnesses in your industry.

I take it you will introduce us to some new terms like printed circuit assembly, and terms of that kind, that we don't know anything about, which we should be very glad to learn about. We are mighty glad to have you, Mr. Mitchell.

You may proceed in your own way.

STATEMENT OF DON G. MITCHELL, CHAIRMAN AND PRESIDENT, SYLVANIA ELECTRIC PRODUCTS, INC.

Mr. MITCHELL. Thank you, Mr. Chairman.

I have a printed document here which I will stick to rather closely. I have some charts that will come on from time to time.

I would like to say that this is not the kind of a discussion which requires my going through it without interruption, so I want you to feel free, if you will, sir, to interrupt at any time and ask for a full explanation of any point. We can enlarge any point, we can cut out any point as we go along, because my sole purpose here is to get you the information you would like to have about our thinking in our industry on this very important subject.

Before I discuss some of the effects of mechanization, or automation, on the electronics industry in general, and my company specifically, I should like to comment briefly on the overall subject before this committee: The current relationship between man and the machine, and the future trends.

I am sure that everyone who has already appeared before this committee, and the subsequent witnesses, will agree that some rather extreme statements have been made about automation during the past year, and particularly in recent months. On the one hand, automation has been deplored as a trend which will disrupt our entire economy; on the other, some rather fantastic claims have been made which would have you believe that the machine will one day relegate man to a life of eternal leisure—monotonous leisure, I might add—interrupted only by occasionally feeding paper tape to some hungry electronic computer.

I know that the first extreme point of view is wrong; the evidence against it is overwhelming, as some of the gentlemen who have already appeared here have pointed out. All I can say about the second point of view is that I don't think that it will ever come to pass, but if it does, I hope I am not around to see it. But I have no real fears on that score; the human being has done a pretty good job of taking care of himself in the past, and I cannot see where the future will be any different.

In studying any trend which seems to pose some immediate or potential problems, it seems to me that we could, of course, have what might be termed a "precautionary" point of view—in other words, what is this trend doing to the economy, and should it be moderated, or perhaps stopped altogether? Far more important, however, is the more positive approach—what opportunities does this trend present, and how can we direct it and stimulate it to be even more productive than it has been in the past?

PROBLEMS ARE OPPORTUNITIES

In the pressure of modern-day living, there is all too little opportunity to project a situation into the future and to imagine the existence of circumstances which do not now exist. The constant and completely understandable tendency is to approach some situation in the light of past experience and current facts, but that is only taking a status quo approach to the problem. Circumstances change rapidly, as we all know, and many a situation which appears at first to constitute a problem, or even a threat, is actually an opportunity to do something more effectively and to a greater common good than has ever been done before.

So it is with mechanization or automation, which are really one and the same thing. Automation is only a more recent term for mechanization which has been going on since the industrial revolution began.

Certainly the machine presents some short-term dislocations which cannot be ignored by anyone, least of all the persons who are dislocated. It doesn't do much good to try to convince an individual worker who does get displaced from an individual job that over a 25 years' span there is such thing as technological unemployment. He doesn't care whether there is or is not. All he is worried about is that he lost a job. Without question every technological improvement has brought broader employment and higher living standards. Sometimes in the process some things may happen which either shouldn't happen or could be substantially minimized. Short-term dislocations present a severe test of management. In this respect I should like to point out that a basic policy at Sylvania has been for many years to make every effort to find a new job for anyone displaced by a machine. We have been extremely successful in implementing this policy; in fact, I do not recall any instance that might be termed a serious dislocation of any sort.

In explaining that, I might add that a large percentage of our employees are women because of the high degree of manual dexterity required in many of our assembly operations. In the main, women do not intend to stay with you until they reach retirement age. The majority of them hope to get married some day, and, therefore, we perhaps do not have some of the problems encountered in industries that employ a hundred percent male labor.

As it does in so many cases—in fact, most cases—the answer to any problems of dislocation seems to lie about midpoint between the extremes, between the strictly emotional point of view, on the one hand, and the overly practical one, on the other. If we recognize that short-term problems do sometimes exist and that they can be resolved, but do not let the existence of short-term situations becloud the fact that the broader and broader use of the machine is overwhelmingly for the common good, then we will have acted in the traditions of a democratic society.

THE IMPACT OF MECHANIZATION ON INDUSTRY AND SYLVANIA

In approaching mechanization or automation from the standpoint of its influences on the electronics industry, Sylvania as a member of that industry, and industry as a whole, a number of general statements can be made:

1. Without large-scale use of automatic and semiautomatic equipment, the electronics industry, as we know it today, would not exist.

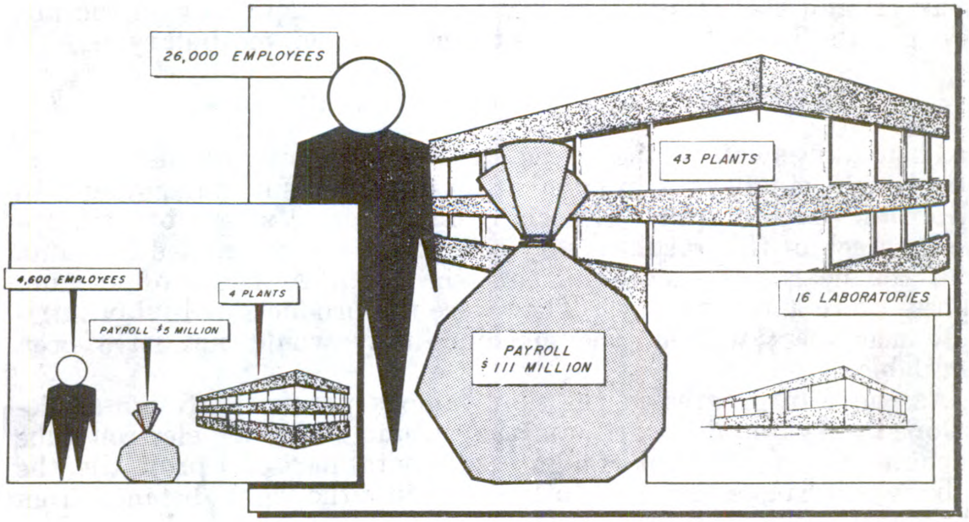
2. Without extensive mechanization, the total working force available to the electronics industry today could not even remotely produce the vast volume and variety of goods needed and demanded by the public, commerce, industry, and the armed services. The machine not only has brought increasingly higher production, steadily decreasing cost to the consumer, and constantly increasing product quality, but has actually met what would otherwise be a labor shortage.

3. The increased demand for, and availability of, the products of the electronics industry has brought a great expansion of the basic materials industries: metals, glass, chemicals, plastics.

4. Thousands upon thousands of small businesses have been formed over the past few years, especially the postwar years, to meet the needs of the electronics manufacturers. Even a largely vertically integrated company such as Sylvania, which produces most of its own components and materials, places millions of dollars worth of business with small concerns all over the Nation.

5. Hundreds of communities have gained new economic strength, either through the expansion of an existing facility, or the advent of a new plant. In 1940, as you will see from the chart (fig. 1), Sylvania had 4 plants, 4,600 employees, and an annual payroll of $5 million; today we have 43 plants and 16 laboratories in 40 communities in 11 States, employment of 26,000, and an annual payroll of

GROWTH OF SYLVANIA
1940 - 1955



$111 million. I use that word "today" advisedly, because other projects are in the planning stage.

6. An enormous new business has sprung up, completely outside the electronics manufacturing business. This is the electronics distribution and service industry, whose distributors, jobbers, dealers, servicemen, and others do an estimated volume of $3 billion annually—a business which did not exist a few years ago, and which has multiplied manyfold since the war.

These are the ramifications of mechanization. It is not a case of putting a machine to work in 1 plant, or 2 plants. It is a case of creating an entire set of industries, hundreds of thousands of jobs that did not exist, millions of dollars of personal income, of buying power, new lifeblood for the entire economy.

THE GROWTH OF THE ELECTRONICS INDUSTRY—"THE WORLD'S MOST PROMISING TECHNOLOGICAL REVOLUTION"

If there ever were an industry which owes its unprecedented growth, its enormous productivity, and its great potential to mechanization, it is the electronics industry. To be sure, this amazing growth over the span of a few short years would not have been possible without rapid strides in the science and engineering of electronics, but advances in the state of the art, no matter how impressive they may be, are in effect meaningless unless they can be translated into the satisfaction of human needs. That was and is the contribution of the machine; it translates the ideas of man into end products within the reach of a steadily increasing number of people.

Not many years ago, as recent as the 1930's and the years immediately before the war, the electronics industry, as such, did not exist. It was essentially the radio business, receivers, tubes, and other components, transmitting equipment, and broadcasting. But there was no microwave communication, no electronic navigational equipment for aircraft and ships, no electronic controls. The "billion dollar baby" of the industry, television, was represented by some very small-scale developmental work in a few laboratories. Then came World War II, and the needs of the fighting forces, especially in the air, brought the word "electronics" into the common vocabulary.

MECHANIZATION VITAL TO MILITARY NEEDS

The requirements of the armed services were not only met but frequently anticipated far in advance by the scientists and engineers in electronics laboratories. Especially in the early stages of development, much of this revolutionary equipment was assembled by hand. But the hearts of the equipment—the countless types of vacuum tubes—were another story. They were the products of highly intricate machines; without the machines they would not have been available.

As the war progressed the now famous proximity fuse was developed. Again, its heart was the vacuum tube, an electron tube capable of being shot out of a gun as the vital part of a projectile, the tube which causes the shell to burst at just the right distance from the target. Then came many other types of tubes, tubes no bigger than the stub of a pencil, yet able to withstand great shock and vibration, as the hearts of communications, navigation, gunnery, and countless other applications.

I have here a few of them. You will see they don't resemble very much the tubes you are used to thinking of as a radio tube. I was going to bring some smaller ones for you, Mr. Chairman, but I find that they become classified as they get to a certain smallness, and I was not able to bring them to you.

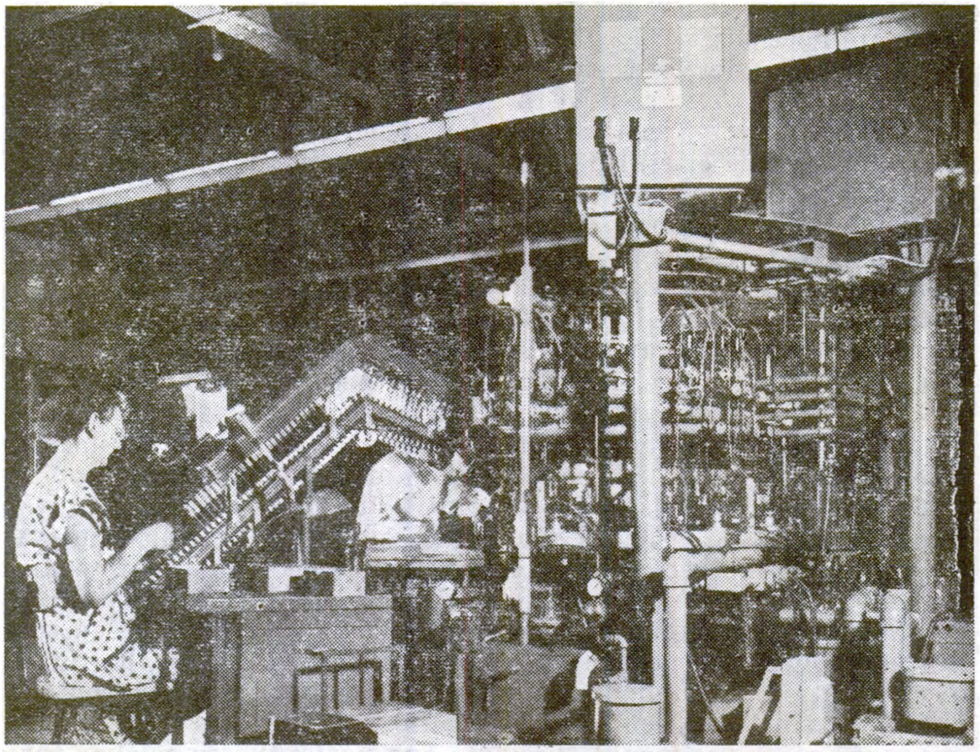
Let me tell you about one of these tubes. During the latter part of World War II, when the armed services' demand for the early version of this electron tube was at its peak, Sylvania employed nearly 15,000 people on this 1 project alone. And that was with the machines that were then available. Even with this splendid and highly efficient working force, national defense needs could not have been met without a high degree of mechanization, not only from the standpoint of production volume, but from the standpoint of duplicating exactly the performance characteristics of a product in each one of hundreds of thousands produced daily. If the United States were to be forced into a period of rapid defense buildup, or a shooting war, the services have become so greatly electronified that their requirements for this type of tube would require an employment of probably 20 or even 25 times that 15,000 employed by Sylvania in 1945, assuming no progress in mechanization since 1945. However, the rate of mechanization throughout the electronics industry in electron tube manufacturing has been so rapid in the past 10 years that new and improved machines would eliminate any necessity for a labor force of 200,000 or 300,000, or even more. In other words, mechanization would prevent a disastrous labor shortage. In fact, I dare say that the armed services' far greater needs for certain types of electronic devices would be met by fewer people than were needed 10 years ago—that is, fewer people for the specific job. There are so many total jobs that the total number of people required would, of course, still be very much greater, but for the specific job, fewer people would be needed to make even the very, very many more tubes that would be required.

RECEIVING TUBES ARE HEART OF ELECTRONIC EQUIPMENT

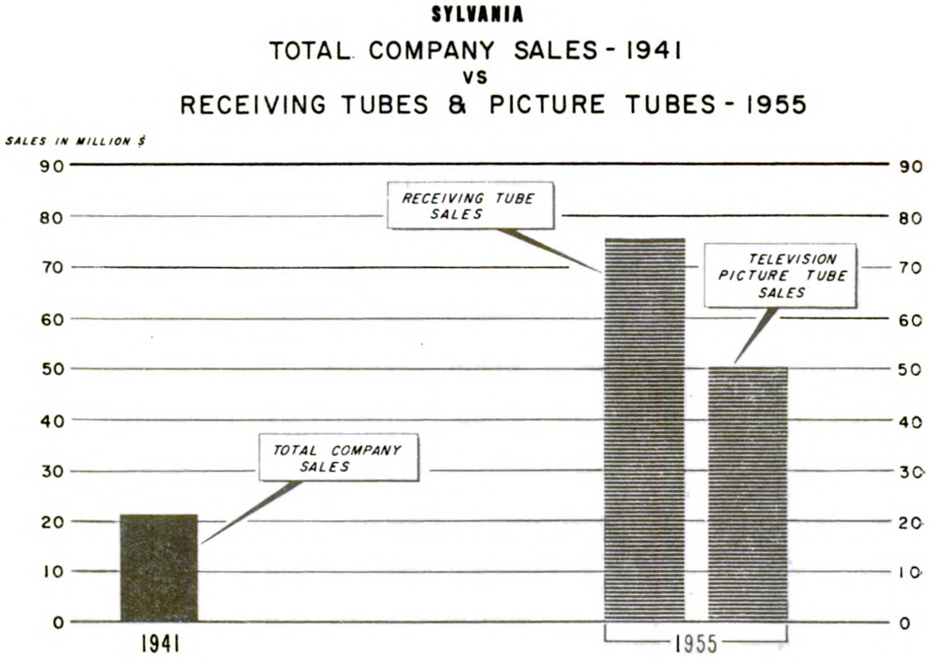
All of these tubes belong to the family known as the receiving tube—the tubes which 30 years ago were the heart of your 1-tube radio sets, and which today are vital to television sets; computers, which are indispensable tools of this electronic age; microwave telephone and telegraph networks, and the countless other uses of electronics. I dwell on this receiving tube because it is a good instance of this automation and mechanization problem.

The machines which produce receiving tubes are a marvel of ingenuity (fig. 2). That picture is also a marvel of ingenuity because it doesn't give away the trade secrets behind the picture.

With unbelievable accuracy, they take the various metallic and glass components and within a few seconds produce a tube without which some vital job cannot be done. The total ouput of a single manufacturing plant today is greater than the entire electronics industry before the war. Sylvania is 1 of the 2 largest receiving-tube producers in the industry, and our output in a single week



far exceeds a million tubes. Since we made our first tube in the early 1920's we have produced many more than a billion of them (fig. 3). You can obtain an even better indication of this growth when I tell you that our receiving-tube business alone is nearly four times greater today than our companywide sales in 1941, which then included not only tubes but also a line of lighting products as well.



That bar on the left indicates our business total in 1941. The center bar represents approximately our receiving-tube business in 1955, and you will see that it is three times as large. The bar on the right shows our television-picture tube business, and you will see that it, again, is twice as large as our total business in 1941, so those 2 products alone represent 5 times as much business as we had total in 1941. It gives you some indication of how the market has expanded for that type of product, because this business was not taken away from anybody else. This is new business that nobody had in 1941.

Coincident with this steady increase in production have come two consumer benefits which are obviously of paramount importance—lower prices and constantly improved quality.

In giving you this example, I would like to point out that I read with considerable interest Mr. Walter Reuther's testimony yesterday, as reported in the Evening Star of last night, and one of the things he is reported as having said is that "Congress should investigate the pricing policies of big corporations because," he said, "the benefits of rising productivity are not being passed on to consumers."

Perhaps in Mr. Walter Reuther's mind we are not a big company. That would probably eliminate us from being included in his statement, but here are some facts of life:

In the early 1930's a typical receiving tube for a radio set cost $6.20. That is the cost if you went in and bought it. If you had someone install it, it might have cost you more. A typical tube today, if there is such a thing, performs a far better job for a longer length of time and costs the consumer about $1.50. That is a reduction of three-fourths, a little more.

Now, all this is in spite of the fact that the average direct labor rate in receiving-tube manufacturing has increased from 34 cents an hour in 1933 to some 5 times that amount today, so the worker gets 5 times as much money. We get one-fourth as much for the product, and now I will give you a little story about profits.

That $6.20 tube had a profit of over 25 cents in it. The $1.50 tube has a profit of perhaps a nickel. Of course, we are making a lot more of them, but if we didn't pass that lower cost of manufacturing on to the consumer then it must be the referee that is beating us to death because we certainly haven't got it. We are making less than a nickel apiece on that tube today.

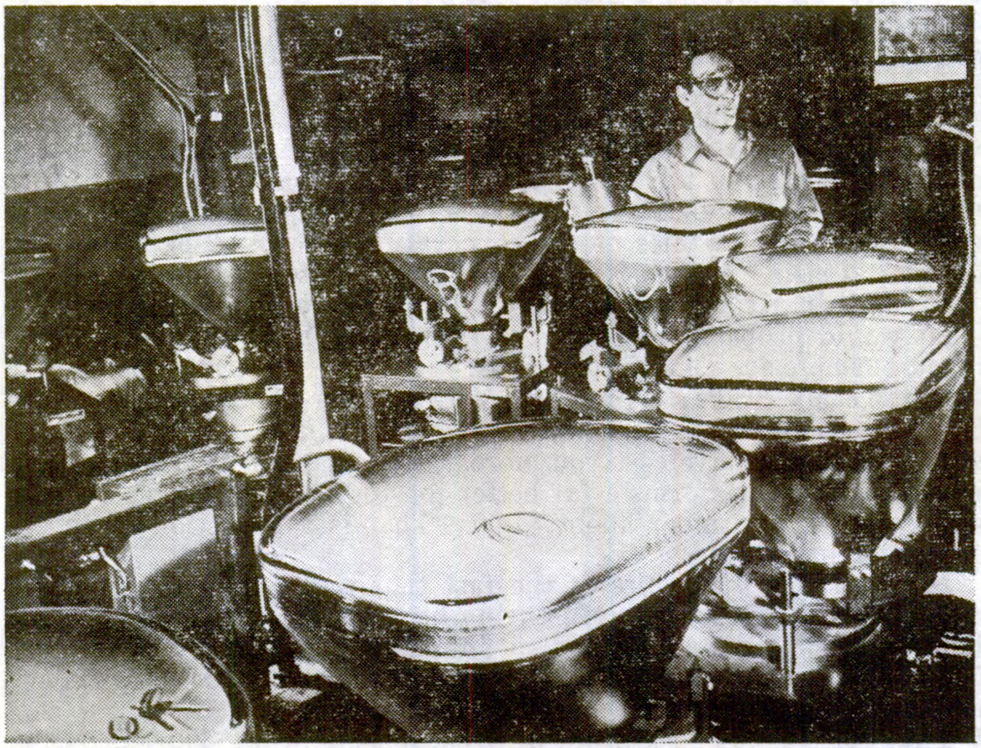
That adds up to a lot of money, and don't let me leave you with the impression that receiving tubes, total dollars, are a small-scale business.

The typical receiving tube today not only does a better job for less money than its counterpart of several years ago, but in many instances it does a job that could not be done at all a few years ago. High as production rates may currently be, and convenient though it may be to produce tube types which have become commonplace to the industry, new types are constantly being introduced to do something which has never been done before.

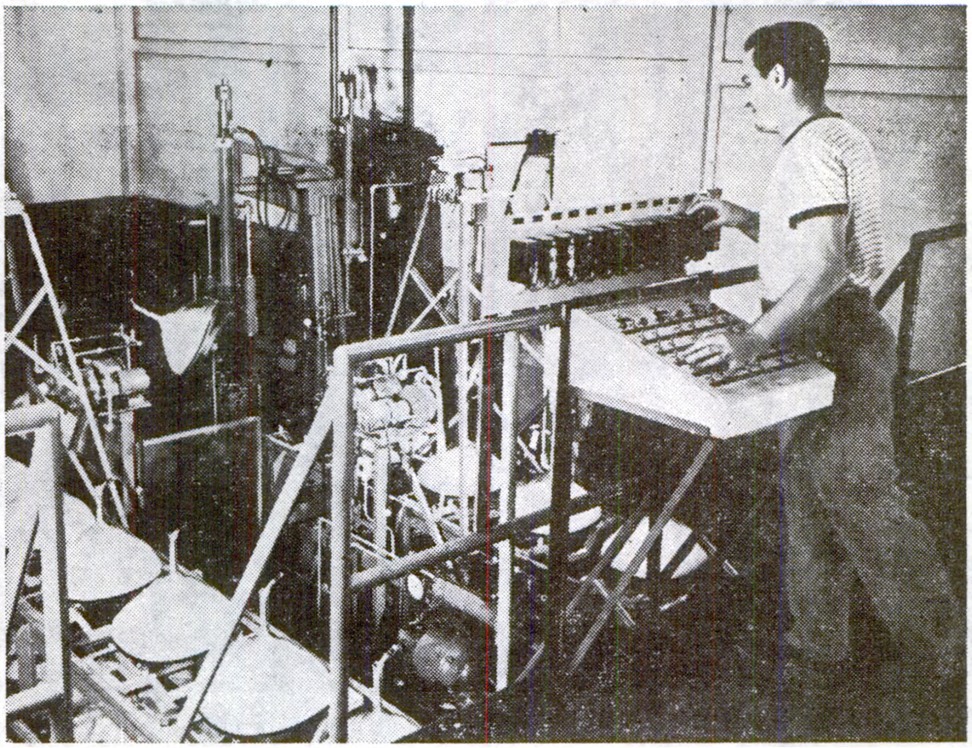
MECHANIZATION BROUGHT TELEVISION TO 35 MILLION HOMES

Still another electronic product which would not be possible without automatic and semiautomatic equipment is the television picture tube, a device which could be found in only a few thousand homes 7 or 8 years ago, but which today brings entertainment, education, and information to 35 million homes. Again this area of our business is today larger than our total company sales just before the war.

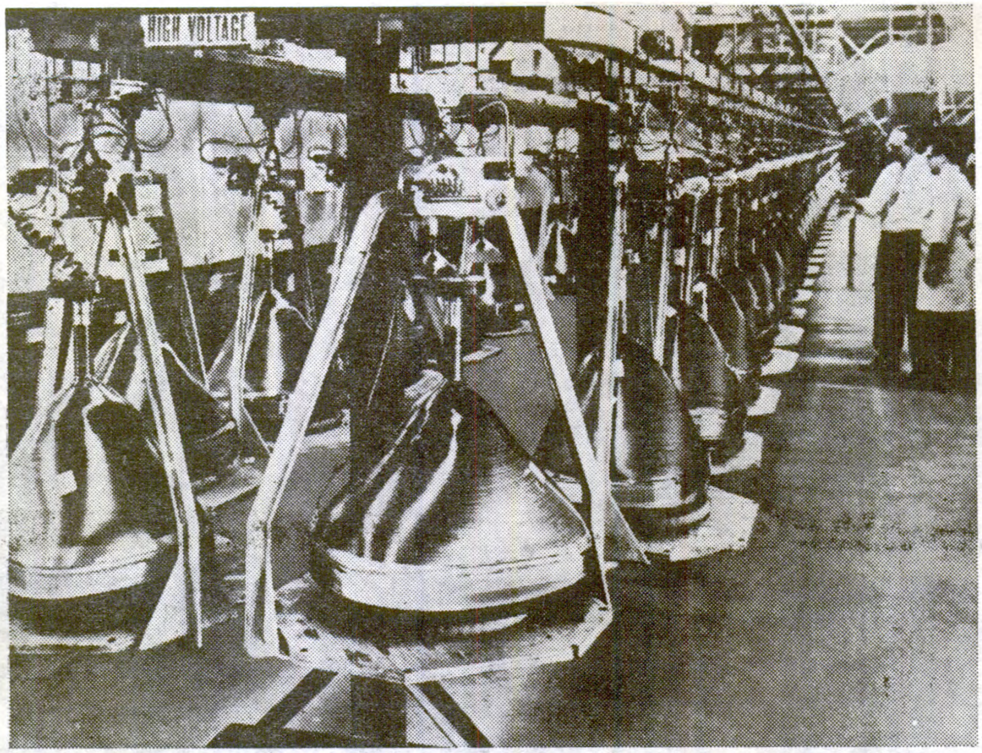
Here are several photographs showing various stages of production in the business of making television picture tubes. That first one is an aluminizing machine, and is probably the most highly automatic aluminizing machine in the industry (fig. 5).



That man is standing at the control panel of a fully automatic screen-settling machine in the manufacture of television picture tubes. He punches buttons when he wants the machine and the conveyor lines to do various things at various speeds (fig. 6).



This is the final electrical test on the line. As they go down there, they are being tested automatically. That fellow who is standing there is an engineer, who is explaining to one of the supervisors or employees about the machine itself.



THE STATUS OF COLOR TELEVISION

The current status of color television is a striking example of the importance of mechanization. One of the major obstacles to the widespread availability of color television is the high cost of a television set. This cost will not be reduced to a point where the set is within the reach of a large segment of the public until the cost of producing the various components can be greatly reduced. New automatic machines are needed, for example, to put the thousands of color dots on the face of the tube, and these machines must apply these dots repetitively, at consistently high quality standards, and at high volume. I am happy to say that such machines are now under development in Sylvania's laboratories.

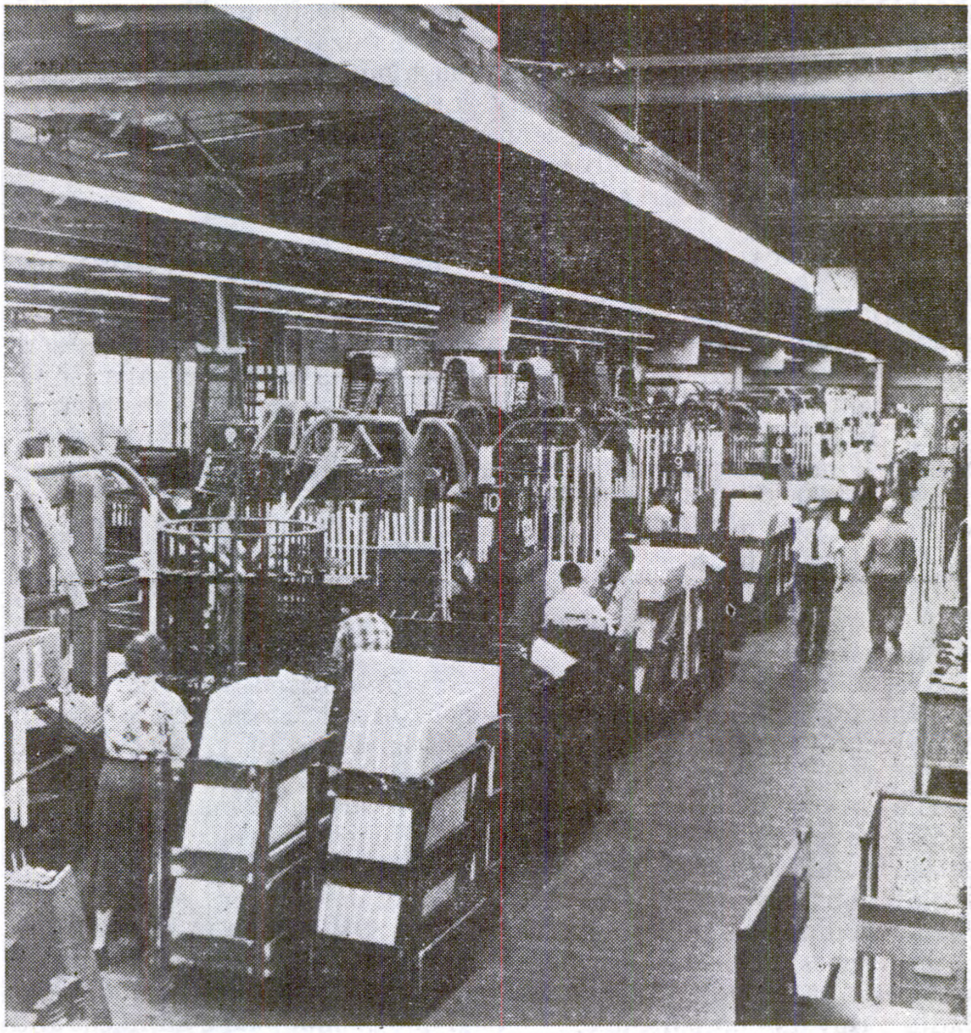
The most expensive component is the color TV tube. When I tell you you have to lay accurately on the face of a color television picture tube hundreds of thousands of separate and individual dots, of three different colors of phosphors, and have each group of three in the exact relationship to each other that the next group of three is, so that when an electronic beam hits the blue dot it also hits the blue dot in the group next door, you have some idea of the complexity and the cost of building such a thing.

Until this is done mechanically, automatically, the cost of color TV sets is not likely to come down where the color TV sets are available to a large number of the public. I am happy to say such sets are under development in Sylvania's laboratories.

Here, then, you have a relatively small device, the receiving tube, and the picture tube, heavy and bulky enough to be difficult for a man to carry, both of them mass-produced items, both of them comparatively new from the standpoint of the jobs they are required to do, and both of them the results of mechanization.

THE FLUORESCENT LAMP

Back in 1938 Sylvania introduced a new product, the fluorescent lamp. There was no fluorescent lamp industry at that time; the fluorescent lamp was, in effect, a laboratory device. From this beginning 17 years ago an entirely new industry has grown, not an industry which supplanted the incandescent lamp industry, but which grew along with it (fig. 7). Here in this photograph is a portion of our fluorescent lamp plant in Danvers, Mass. None of these jobs existed 17 years ago, nor any of the nearly 1,000 others at this plant.



Let me repeat: All of those jobs that you see in that picture, and a thousand more like them in the same factory, are jobs that did not exist in 1938 at all. So those machines didn't take jobs away from anybody. They created new jobs.

To show you what is happening in this business, our fluorescent lamp production per operator-hour in 1940 was 3.4, a little less than three and a half lamps per operator-hour. Today the equivalent figure is above 50. I would rather not give you the exact figures because our competition would like very much to know how fast we are making them, but I firmly believe that within the next 5 years the production per operator-hour will have to more than double again, if we are to keep pace with greater public demand for our product. An enormous expansion in lighting will take place during the next several years, and mechanization will be the only way to meet that demand.

Although the receiving tube business is one of Sylvania's oldest product lines, two of the products I have mentioned—fluorescent lamps and TV picture tubes—represent relatively new products whose introduction and growth to the substantial position they now hold would not have been possible without mechanization.

I might add a third product, photoflash bulbs. The point, however, is this: Mechanization has not only greatly broadened our business in such original lines as incandescent lamps and receiving tubes, but has permitted us to enter entirely new lines of business, every one of which either equals or surpasses our total sales of 15 years ago.

ELECTRONICS: A $9½ BILLION INDUSTRY FROM MECHANIZATION

Other companies in the electronics industry have equally impressive stories to tell. Some of them are large organizations with considerable diversity of product, whereas others specialize in perhaps 1 or 2 components or in some very intricate device, such as the magnetron tube. In total, however, all of us represent an industry with a total annual volume of some nine and one-half billion dollars, employing more than 700,000 persons. A decade and a half ago, annual volume was about $500 million, and employment of about one-tenth of what we have today (fig. 8).

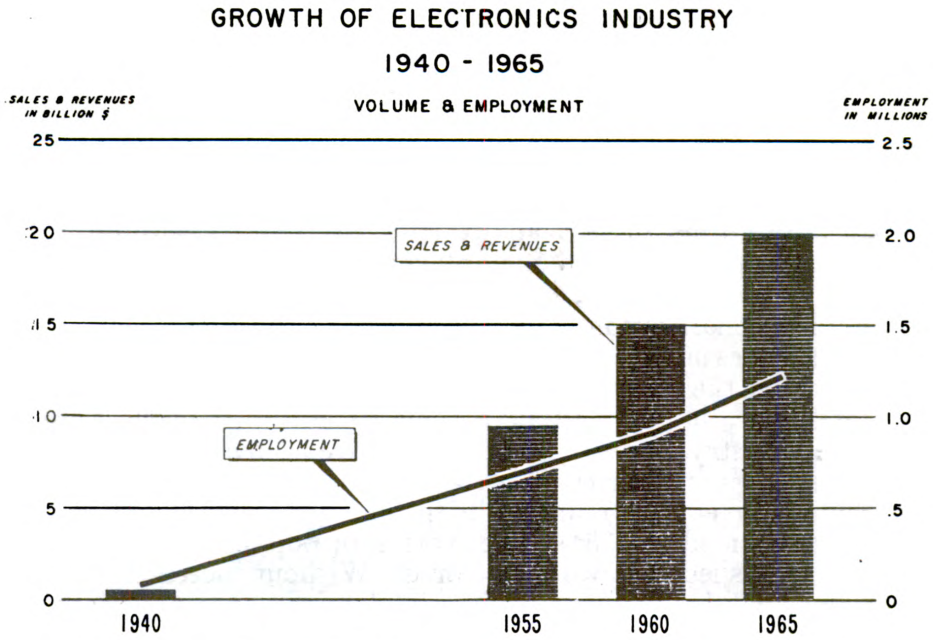
The bar chart and the lines are actually drawn to scale on that chart, and therefore, it proves that employment has grown as rapidly as the industry.

Keep in mind that those are not solely production workers. Those are the distribution workers, salesmen, broadcasters, and so forth, everybody who is employed in this electronics industry, whether he is a production worker or not.

The CHAIRMAN. Does that include the local serviceman?

Mr. MITCHELL. Yes; it includes servicemen as well. This is the entire industry.

Now, obviously, the growth of production workers alone in the plants wouldn't be as rapid as that. That $9½ billion in annual sales and revenues includes Government purchases, most of it for the armed services. It includes TV and radio transmitting equipment, TV and radio receivers, components, industrial and commercial equipment and devices, distribution, service, and the vast broadcasting industry. Each of these areas has a strong growth potential, but without ques-



GROWTH OF ELECTRONICS INDUSTRY
1940 - 1965

tion the field with the greatest fertility is industrial and commercial electronics—the application of the vacuum tube and all of its attendant devices to mass production, to business communications, to transportation. So broad is the horizon, in fact, that the most conservative estimates are that the electronics industry will attain an annual volume of $15 billion, or perhaps more, by 1960, and $20 billion by 1964 to 1965, with employment exceeding 1 million people. Think of it. An industry which has doubled in the postwar years, will double again within the next decade.

Let me hasten to add that these predictions are not wishful thinking or crystal-ball gazing. They are based on realistic projections of current trends, population growth, formation of new families, industrial expansion, and other predictable factors. If anything, these predictions are on the conservative side, and the next year may well find us revising our estimates upward.

One extremely important consideration in making such appraisals of the years ahead is a continuation of the trend in mechanization and automation.

INCREASED MECHANIZATION RATE INEVITABLE

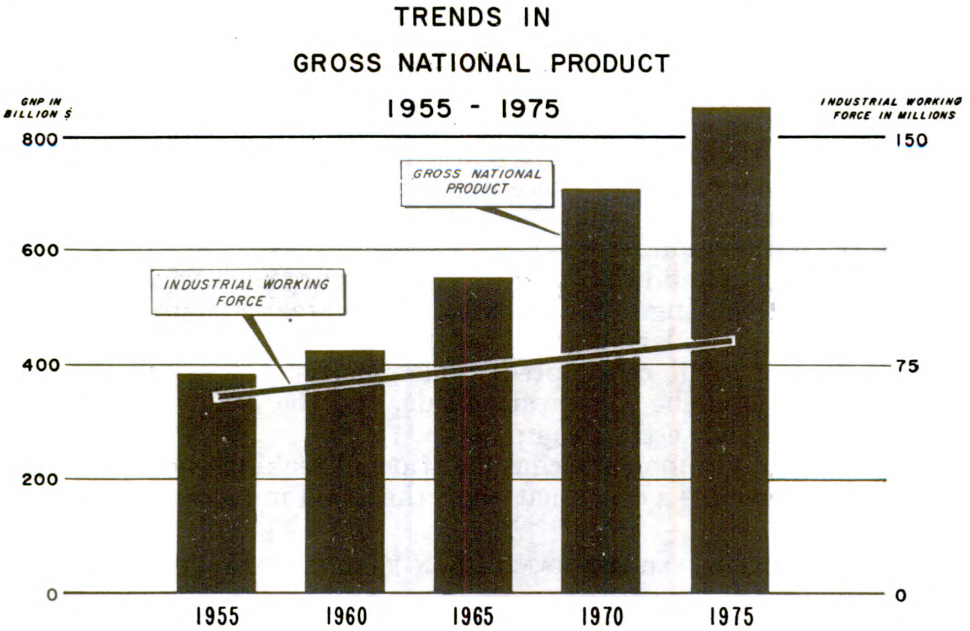
It is our frank opinion at Sylvania that the momentum of technological advances in the art of mass production is such that continued mechanization on even a broader scale is inevitable in the years ahead. Whether you have in mind 100 percent mechanization of a single given process, or partial mechanization, finding better ways of doing things is a human trait which cannot be erased. The human mind has a habit of not standing still, and not accepting the way things are done today as the only answer.

As I indicated earlier, and as many speakers on the subject of automation have pointed out in recent months, increased mechanization is the only answer to satisfying the human needs which increase day after day. Let us assume that by some fiat techonolgical advances were stopped dead in their tracks. The needs of this Nation are expanding so steadily that within a very short period of time we would be confronted with a peacetime phenomenon we have never encountered before over any period of time—a serious labor shortage.

ONLY INCREASED MECHANIZATION RATE WILL MEET HUMAN NEEDS

I not only do not even remotely fear that mechanization or automation will cause long-term unemployment, but I am concerned about the strong possibility of a labor shortage in the years ahead, unless the rate of mechanization is increased.

The past gives us a good clue to the future. As reported by the Joint Committee on the Economic Report, and the United States Department of Labor, at year end 1947, some 44 million persons were employed in industry; in 1954, 50 million were employed. If production techniques had not progressed between 1947 and 1954, 58 million persons would have been required to produce the goods and services actually demanded in 1954. The American population simply could not have furnished that working force. Without increased mechanization, without laborsaving devices, and overall greater production efficiency, the public's needs simply would not have been met.



Now, let us look at the future. I recently read a survey in Factory Management and Maintenance magazine in which a gross national product of $850 billion was predicted for 1975; as shown on the chart. Now, unless you buy the fact that it is possible to have that gross national product of $850 billion by 1975, then the rest of my argument is specious, but I believe that high a gross national product of that magnitude is possible, and I believe we will have it.

Our gross national product will be this year about $382 billion. Factory and Management Maintenance also predicted a working force in 1975 of 82 million people against 64 million people today. They point out if the present rate of automation continues, every available worker will have to be putting in 40 hours per week, in order to keep raising our standard of living at the rate it is being increased now. The entire Nation's long-term goal of a shorter workweek would be impossible. If Mr. Reuther wants the 32-hour workweek, which he says he does as quoted in yesterday's newspaper, then we had better get on the ball and speed up automation because if we don't, he cannot have it. A 32-hour workweek, for example, would require an estimated 105 million persons, and that large a force will not exist.

There is no question but that the rate of mechanization will have to be increased if we are to realize its ambitions of both a steadily rising standard of living and a shorter workweek.

Perhaps because we are a growing company in an expanding field, but also because I am sure that the unions see throughout Sylvania many examples of the creation of broader job opportunities through high mechanization, I know of no instance of any difficulties with our various unions through our introduction of new machines. The unions know as well as we do that increased mechanization at Sylvania has given us the competitive strength to create broader markets for our goods—and that means more jobs and more security.

With your permission, Mr. Chairman, I would like to say a word or two about decentralization. You have asked me something about it earlier.

The CHAIRMAN. Yes, sir; we are interested in that. Where are your plants located principally?

Mr. MITCHELL. (Fig. 10). That is a pretty small map, but you can see that they are concentrated in two main spots. There are 11 of them in New England, 24 in Pennsylvania, 15 in New York. Then they go out through the Middle West and down into the South, and there are three on the west coast.

The CHAIRMAN. I am acquainted with your company because I always listen to Mr. Collier and his program Beat the Clock.

Mr. MITCHELL. Thank you for that plug, Congressman. I appreciate it.

DECENTRALIZATION: KEY TO PROGRESS

I should like to discuss two situations in Sylvania which are indicative of what is going on throughout the electrical-electronics industry. One is the philosophy of organization known as decentralization, and the other is the steadily increased use of automatic equipment in data processing. The only difference between decentralization, as we see it, and as others preach it, is that some people have gotten the idea that decentralization means physical dispersion.

Now, it happens, too, in our case, but can you decentralize without physically dispersing? Decentralization is a philosophy of management which means that you pass on authority and responsibility down the line, and really require your executives at lower levels to do the complete job, themselves, and be responsible for everything, including profits.

If I had to personally make decisions on everything that goes on in those 43 plants, 16 laboratories, and 15 warehouses, I wouldn't be able to be here today, sir, giving this testimony. It is only because we really practice decentralization that it becomes possible for one man to attempt to manage a corporation of that size.

Now, we claim that decentralization would not be possible without mechanization. We favor small plants in small towns. We favor them for many reasons. We believe that one man cannot know individually more than several hundred people in one plant. He cannot go through the plant and call them by their first names, Tom, Joe, Harry, and he cannot really know what they are doing in his factory, if there are many more than six or seven hundred, so we put a theoretical limit, which factors beyond our control cause us to violate every once in a while, of about 700 people, and it averages out about that. We have 26,000 employees in 43 plants and other installations so we are not far off our goal as an average, but if we put some of these factories in the small towns they are in now, such as Nelsonville, Ohio, or Burlington, Iowa, or Shawnee, Okla., or Fullerton, Calif., if we didn't have them highly mechanized, we couldn't put them in the small towns because the small towns wouldn't deliver a labor force big enough to let us have them. We would have to draw from the farms around and the transportation problem would be too great. So we do say that decentralization, as we run it, could not be accomplished without mechanization. These are highly mechanized plants, with few employees, with a small supervisory force watching over them.

The manager of such an operation, in effect, has a separate business, and he runs it subject only to the broad framework of general policies and controls which must be retained by top management in order to assure coordinated action. Knowing that he has the responsibility for the success of that local plant, and that he has the necessary authority to do the job, that manager has the same sense of pride as if he personally owned every square inch of that plant. And that pride is strikingly evident in everything that he does.

Moreover, that point of view permeates right on down through his entire organization. Everyone in the plant, from the receptionist at the front door, to the shipping clerks at the back, know that the local manager is running the plant, and not some main office a thousand miles away. They see that what they do has a direct effect on what he does, and they proceed to identify themselves directly with the success of that operation.

When you walk through the plant, you see in a moment what the attitude is. The first names, inquiring about the family, discussing some new machine as if they had paid for it themselves—not simply acting interested because the book says you should, but rather because you are interested—these are the symptoms of a healthy situation.

A DECENTRALIZED PLANT STRENGTHENS COMMUNITY PRIDE

This sets off a sort of chain reaction which extends from the plant out into the community. A decentralized plant, operated as an integral part of the community, seems to breed a certain point of view—an awareness of community responsibilities and a desire to do something about them. Whether it is a fund-raising campaign for a new church, or the community chest, or anything else, everyone seems to get behind them and views them as part of his individual responsibility.

Aside from the obvious advantages from a human relations standpoint, which are sufficient reasons in themselves for decentralization, what are the other benefits? There is no question but that a decentralized plant, making a product which lends itself to decentralization—and there are plenty of them in the electrical-electronics industry—is more efficient than one operating under centralized authority and responsibility. This is the reason: It is more efficient because everyone wants it to be. The working force at that plant doesn't work any harder, but it does work more effectively. It isn't the machine that does it; the machine only makes it possible for us to set up an autonomous operation. The point of view of the employees, from the manager on down, the attitude—that is the key to the situation.

SOME LIMITS TO DECENTRALIZATION

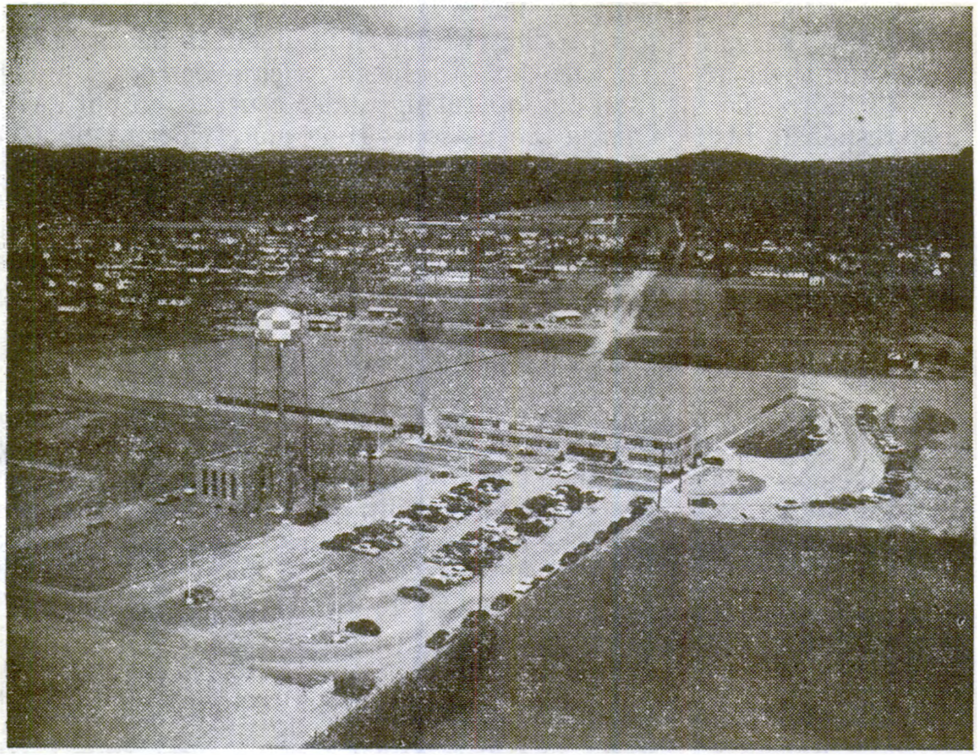
We sincerely do not know how far a company can go in decentralizing. A great deal depends on its products, for example. Obviously, a producer of heavy equipment would find it difficult to decentralize the way we have, because we can break up our operations into units, and he cannot. Likewise, the mass production of automobiles would not seem to lend itself to decentralization into many small plants, although the production of components and subassemblies certainly could be.

Be that as it may, we know that Sylvania could not have decentralized without mechanization. And we also know that wonders can be worked by several hundred skilled people, operating highly complex machines, in a decentralized plant, in a small or medium-sized town, when that one plant does not dominate the community. The resultant consistently high quality of product, and overall competitive costs, are vital to a company's continued growth and prosperity—and that means expanding opportunities for employment.

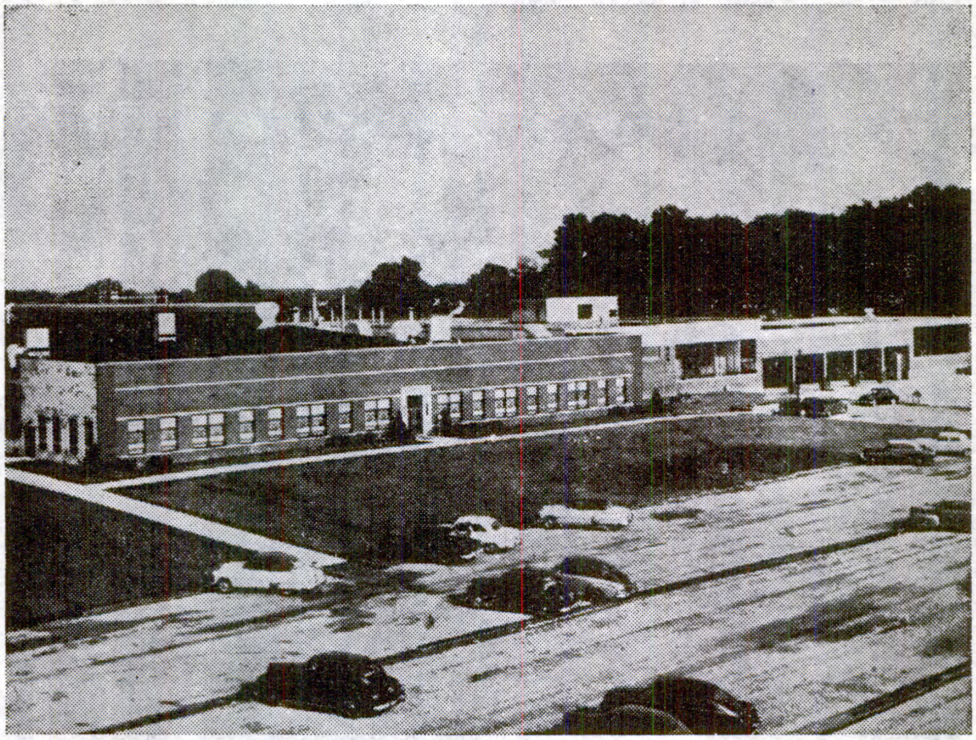
Without mechanization we would never have been able to take our work to many small communities because their labor force would have been inadequate. We would have had to build our plants in large industrial centers, instead of Shawnee, Okla., or Burlington, Iowa, or Fullerton, Calif.

Suffice it to say that the employees in a decentralized plant don't work any harder, but they work more effectively. A pitcher works just as hard throwing a wild pitch as he does a strike.

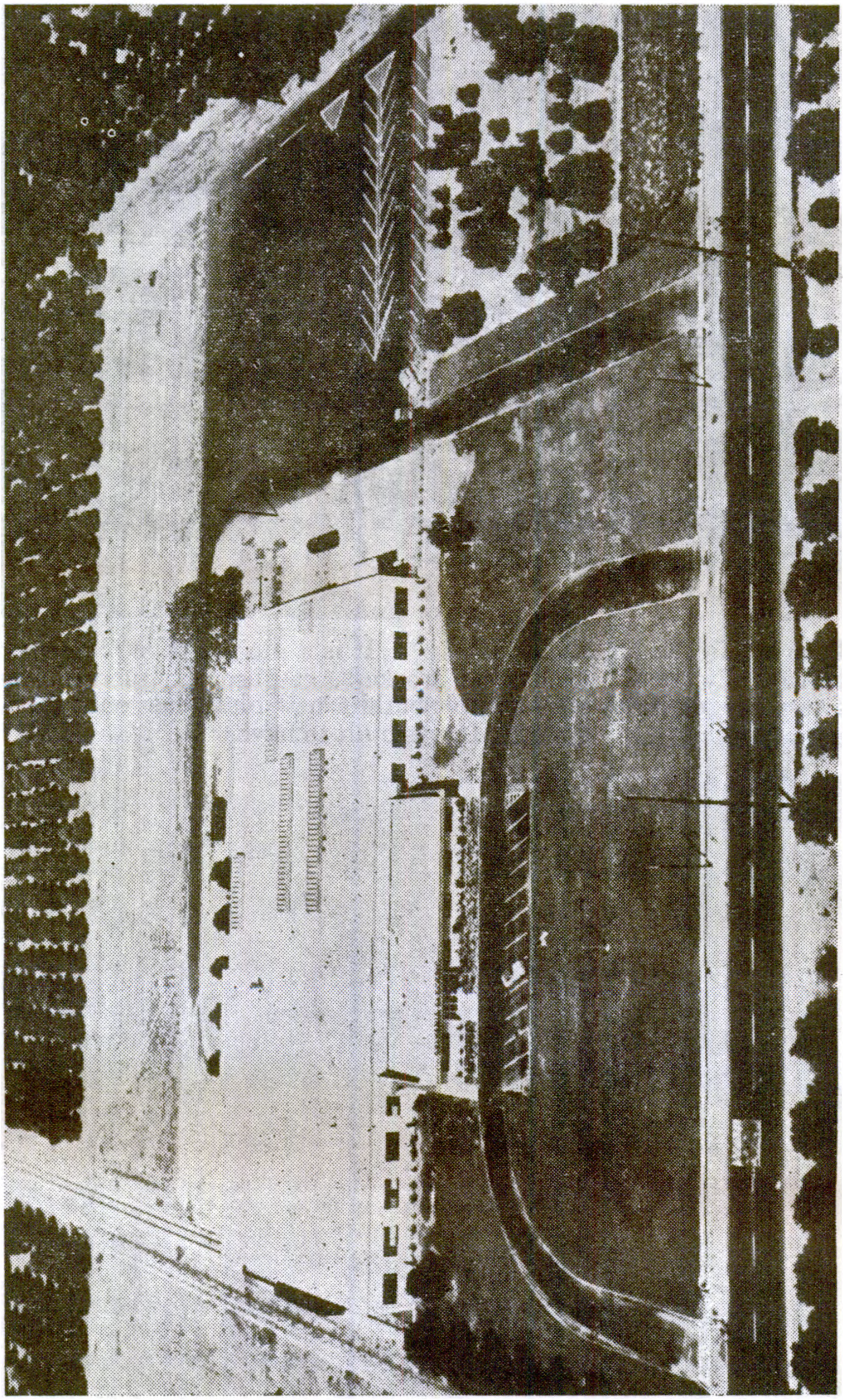
Yes, Sylvania is sold on decentralization. We think that it is good for the company, for the employees, for the communities, and for our customers. It represents a blending of the advantages of mass production without submerging the individual in the process. Call it "maintaining the identity of the individual." That seems to be sufficient reason in itself for decentralization.



Here is a typical example (fig. 11). Some of you won't think that is a very small plant, but that one is in Williamsport, Pa. It has about 600 workers, and they are all supplied from that area.



That one is Ottawa, Ohio (fig. 12). It is a picture-tube plant, and unfortunately, over a thousand workers, because the picture-tube business got too big. We couldn't build a new plant fast enough, so it has a thousand people in it. It was built to have 600.



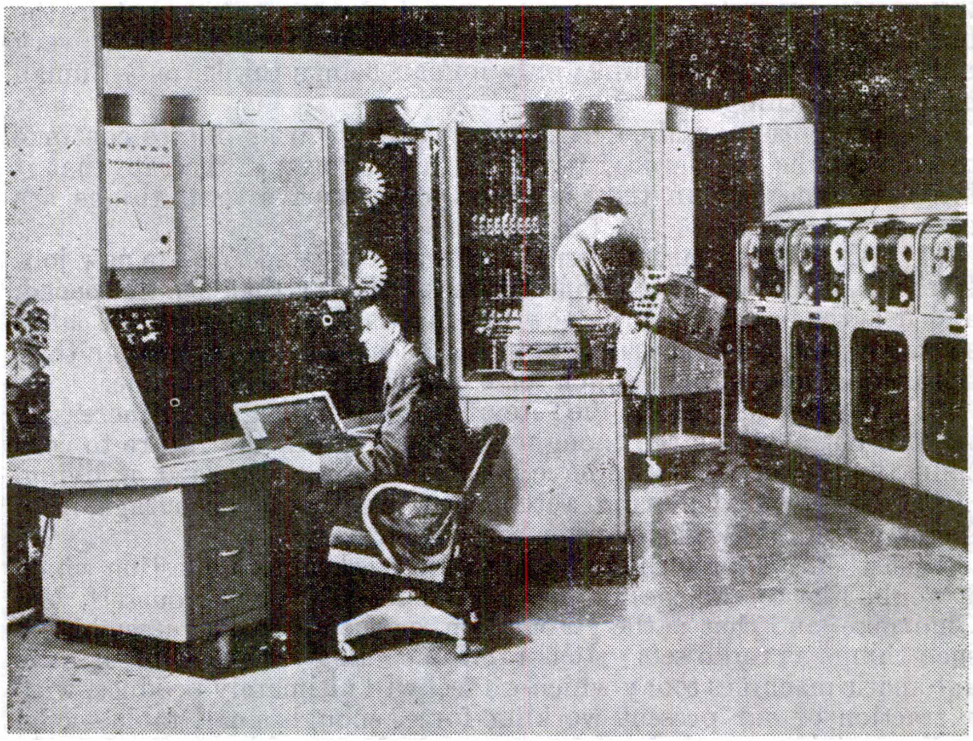
(This one is the Fullerton, Calif., picture-tube plant (fig. 13).

Now, we believe that the combination of further mechanization and further decentralization is going to help us arrive at the goal where small towns, or smaller communities can have their own industrial plants—where labor, the younger fellows and gals, are not drained away from these small towns to work in larger cities, and we think it is for the general good of everybody to be able to work in a smaller community, where commuting is not necessary and where you can live 10 or 15 miles from your work and perhaps live in a spot where you can have a little garden plot of your own, and so forth.

That is the basic philosophy of our decentralization program, and I will show you now what we are doing to carry mechanization one step further to make decentralization and mechanization really possible, and that is, we are going to automate the figure part of the business, the clerical part of the business.

SYLVANIA'S DATA PROCESSING SYSTEM

And now, in conclusion, I should like to report briefly on a new project at Sylvania which represents a form of pioneering in the use of automatic equipment. It is our new data processing system, the headquarters of which is now under construction in the little town of Camillus, just outside Syracuse, N. Y. (fig. 14). A nationwide 12,000-mile private electronic communications system, engineered jointly by Sylvania and Western Union, will link 51 cities with the data processing center at Syracuse. These specialized communications facilities will tie together all of our plants, laboratories, sales offices, warehouses, divisional headquarters, and executive offices. These various installations will feed financial and production information over the



leased network to the center, where it will be instantly summarized for all levels of management.

The heart of the center will be a Univac machine which we will lease from the Sperry-Rand Corp. (fig. 14). The giant electronic brain will convert a wide variety of information into summarized data on which can be based decisions by management at the corporate, divisional, and plant level. It will gather, record, compute, and classify information concerning production volume, sales, billing, and many other activities. And as we gain experience we fully expect to broaden its activities to such areas as market research, engineering analysis, and other fields.

Western Union, Sperry-Rand, and Sylvania look upon this new project as a revolutionary step in industrial communications. It is, as far as we know, the only existing concept of an entire company tied together communicationswise from a data processing standpoint, and with that function housed in its own facility. Of equal significance is the fact that this project in administrative automation will be of tremendous value to an operating organization whose very foundation is mechanization and automation. Here, too, will be a centralized facility making even more effective a fully decentralized operating organization.

I should like to emphasize that ingenious as it is, Univac cannot think. It can only give out what somebody has put into it in the first place. It does the process of manipulating that information very rapidly, but it cannot think; only human beings think; only human beings make things.

Our contention is, Mr. Chairman, that if we are going to continue to increase the standard of living of this country at the rate that it has been increased in the past few years, then several things are necessary:

(1) We believe that mechanization must continue to make new jobs faster than it takes people off old ones. So far that has happened, and it is the creation of the new job that is likely to cause the labor shortage that I am worried about in the next 20 years, rather than the army of unemployed which some people fear as of that time.

(2) We feel that unless the rate of automation is greatly increased, we will not have a large enough working force in the future to continue the rate at which we have been raising our standard of living.

(3) Far from deploring automation, we should encourage it to increase at a rate we have never before attained.

Just when I entered the room, Mr. Moore asked me a question which I would like to enlarge upon, and you touched on it yourself, Mr. Chairman, and that is the automation, or the automatic assembly of such things as radio sets. It is rapidly coming. Several of us have automatic machines today which we feel will ultimately produce, with a fraction of our present working force, enough small table model radios to take care of at least 50 percent of what this country uses in a year.

Offhand, it might seem that a tremendous number of people would be thrown out of work.

Well, there are some compensating factors that you must take into consideration. An automatic assembly machine of that kind, spews out an awful lot of radio sets, but every one is like the one before, and not everybody wants every radio exactly the same color, shape, size, and style. They want different ones. Therefore, you can't afford to set up an automatic machine, to spew out that many radios of the same kind at the same time, so it becomes more expensive to make them this way than it does to make them the way that we are making them today, so we don't make complete units. We make perhaps a little part, which is common to very many television or radio sets, called an assembly, and we can make that thing in great quantities, and supply it to many small assemblies of television and radio sets who could not make their own assemblies. That is the way the industry is developing.

Do not get a picture of a great funnel at one end of a machine into which you pour raw materials and out of which at the other end comes a completely assembled device. We won't live to see that today, and I doubt that our children do.

Automation comes in bits and pieces. First the automating of a single process, and then gradually a tying together of several processes to get a group or subassembly complete.

I think I will end there and see if you have any questions, sir.

The CHAIRMAN. I have certainly enjoyed your testimony, Mr. Mitchell. I know very little about this very complicated and important problem, but I am learning a great deal about it.

Your testimony states that the industry which has doubled in the postwar years will double again within the next decade, that is by 1965.

Mr. MITCHELL. Yes, sir.

The CHAIRMAN. By 1965 the estimate is that we will have 190 million people. What is your estimate of population by 1975?

Mr. MITCHELL. About 225.

The CHAIRMAN. About 225 million people.

Mr. MITCHELL. Yes, sir.

The CHAIRMAN. I notice that you state that you are in agreement with the estimate that has been made that we will have an $850 billion gross national product by 1975.

Well, what percentage a year will that be?

Mr. MITCHELL. Well, let's see. It has 20 years to do it in.

The CHAIRMAN. Without allowing for the effect of compound interest, that would be more than 5 percent, since it will be more than double. Right now we have less than 400.

Mr. MITCHELL. Yes, sir. It will be more than 5 percent?

The CHAIRMAN. It will be more than 5 percent. Will it be as much as 6 percent?

Mr. MITCHELL. Pretty close.

The CHAIRMAN. It will be pretty close to 6 percent. That is the highest estimate we have had of the increase in the gross national product.

Mr. MITCHELL. The reason I believe it, Mr. Chairman, is that every time that you build an automatic machine, the thing opens up new vistas of things you can do with it, and products that you can make available, that you never dreamed of before, and if you believe, as I do, that the human being never becomes saturated with things—there are always other things he wants, if he can afford to buy them—then I say that this rate of increase can increase by that amount, by that time.

The **Chairman.** What is your prediction on the workweek for, say, 1965?

Mr. **Mitchell.** Well, I gave you my prediction in 1975, and if I can draw a straight line between now and there, I would say that the problem would be partially with us in 1965—namely, that I doubt you can get down to a 35-hour workweek, because I think the demand for goods will be so great that the working force will have to work nearly 40 hours a week to produce those goods, unless we step up even faster our automation process.

I have no objection to a 35-hour workweek. I just don't think you can get down to it without stepping up our rate of automation.

The **Chairman.** You have the same feeling about 1975?

Mr. **Mitchell.** Yes, sir. I believe it will be close to 40 hours.

The **Chairman.** You will still have the 40-hour week?

Mr. **Mitchell.** Unless we build things faster, unless we mechanize faster.

The **Chairman.** For the reasons that you have already stated.

Mr. **Mitchell.** Of course I was brought up in the sales department, Mr. Chairman. Nobody can tell me that you can't peddle this much goods, you see. Somebody who was brought up in production might doubt that you could sell that much output.

The **Chairman.** Do you depend on installment buying for distribution of your products?

Mr. **Mitchell.** Yes, sir.

The **Chairman.** What percentage of your products would be distributed through installment buying?

Mr. **Mitchell.** I think a very small percentage of our own, sir. Our TV business is only about 15 percent of our total, and most of our other products are sold for cash.

The **Chairman.** It is only the TV part that would depend upon installment credit to any great extent, then?

Mr. **Mitchell.** Yes, sir.

The **Chairman.** When do you predict we will have in general use the colored television?

Mr. **Mitchell.** Well, sir, I am a conservative on that, because I want to see the colored TV set be one that you and I can operate without an engineer standing over our shoulder when it comes about. It is here today. I have one in my living room. It only costs too much, and it is a little too complicated to tune. I would say that you will begin to see them in quantity at the end of 1956, and I believe that 1957 will be the first year when what we would call large quantities will be sold. If you want to know the price, I think it will have to be $500 or less before enough people will buy them.

The **Chairman.** Senator Watkins' administrative assistant would like to ask you some questions.

Mr. **Frischknecht.** Mr. Mitchell, Senator Watkins is a member of this committee. He is in Utah at the present time. This is the first time the Senator has been in the State for 2 or 3 years. At this time last year he was busily engaged in a senatorial assignment; therefore this is the first opportunity he has had to get out home for a needed vacation and to meet the people and ascertain their problems. He is on his way today, I think, to the National Reclamation Association convention in the Midwest, and for that reason cannot be here.

Senator Watkins asked me to attend the hearings in his place, and the chairman of the subcommittee has been gracious enough to permit me on behalf of Senator Watkins to ask the witnesses appearing before the committee a few questions.

I was most interested in your observation that as far as Sylvania's productive processes are concerned, about 70 percent of your employees are women.

Mr. MITCHELL. Yes, sir.

Mr. FRISCHKNECHT. Then as far as displacement of workers is concerned, through the introduction of some of this excellent and very astonishing automatic equipment you told us about this morning, you really haven't too great a problem as far as your own company is concerned?

Mr. MITCHELL. No. Well, remember, now, there are two reasons why we have it. One is perhaps that a large percentage of them are women, and, therefore, our personnel turnover is larger. The second reason is that the industry has grown so fast that we can absorb almost anybody we can hire.

Mr. FRISCHKNECHT. Has this problem reached such proportions that Sylvania has had to establish a retraining program? Do you have a current retraining program?

Mr. MITCHELL. In individual plants, yes.

Mr. FRISCHKNECHT. In individual plants, where you are in the process of new adaptation?

Mr. MITCHELL. Yes, sir.

Mr. FRISCHKNECHT. Is this generally true of the industry?

Mr. MITCHELL. I would think to a degree; yes, sir.

Mr. FRISCHKNECHT. I was also interested——

Mr. MITCHELL. I hope we are a little ahead of them.

Mr. FRISCHKNECHT. I was also interested in your observation that rather than automation ever resulting in too many unemployed individuals, actually automation itself may result in a deficit in the number of employees available for future employment.

I was also impressed by your observation that as far as your industry is concerned, the introduction of automatic equipment has resulted in decreased prices, and an increase in quality and an increase in the quantity of your products available to the public.

Mr. MITCHELL. Could I add one that I forgot to say in my testimony? One of the greatest costs in the electronics industry is, believe it or not, sheer waste, a thing that we call in the industry shrinkage. We put dollars worth of raw materials into one of these big picture tubes and if it isn't right when this comes off the last process, the whole thing goes into the scrap pile, except for the glass envelope which we wash out and try to start off again.

This shrinkage is the greatest single menace of the industry.

The amazing thing is that fully automatic machines don't make shrinkage. The machine stops when you put a bad part or bad process in, so you tend toward the time where every unit that comes off the end of the line, off the completely automatic machine, is a good product. This doesn't hurt anybody. This is the elimination of waste.

Mr. FRISCHKNECHT. This is a factor resulting in lower per unit costs.

Mr. MITCHELL. Yes, sir.

Mr. **Frischknecht**. Resulting in lower prices to consumers.

Mr. **Mitchell**. Yes, sir.

Mr. **Frischknecht**. You also mentioned that as of this date your firm has had no difficulty with labor unions, over problems created by automation.

Mr. **Mitchell**. No, sir.

Mr. **Frischknecht**. With respect to automation.

Mr. **Mitchell**. No, sir. In respect to automatic machinery. We have had a few little bones of contention in other regards, as does any company.

Mr. **Frischknecht**. My reference is purely to problems as a result of automation.

I was particularly interested in the description you gave of your plant dispersal program—called decentralization by some, relocation by other authorities on administration and management.

You indicated something about new employment opportunities in rural areas. Do you think this might be one reason, not due just to your plant or your firm's operating this way but the fact that many other industries, and many other firms, are utilizing this dispersal method also, why we find fewer farmers today? We have steadily experienced a decline in the number of people in agriculture. We haven't found a corresponding decline in the number of people leaving rural areas. Do you think, therefore, that there is a possibility that many of these farmers or people who were farmers at one time have gradually been absorbed in plants such as those you have located in the South, the Midwest, and California?

Mr. **Mitchell**. Yes, sir; we employ a lot of them. Some of them are part-time truck gardeners when they go home at night, but they don't consider themselves farmers any more. They consider themselves industrial workers and would be so classified.

Mr. **Frischknecht**. I am glad you make that point.

According to the census of 1950 we had out of about 5.4 million farmers about a million heads of farm families who worked over a hundred days off the farm. Many of those individuals might well be employees of small plants located in rural areas, such as Sylvania's, may they not?

Mr. **Mitchell**. Yes, sir. We give local plants their local choice as to what hours they would like to work. We open many of our plants in farm areas at 7 o'clock in the morning, so they can get through at 3 in the afternoon, and then they go home and farm after that.

Mr. **Frischknecht**. I think the members of the committee are well apprised of the fact that one of the main features of President Eisenhower's and Secretary Benson's program for low-income farmers hinges right upon this very point you have made. That is the need for the location in the rural areas, in low-income farm areas, of plants such as Sylvania has built in the Midwest, California, and in the South. I was particularly interested to know that you have a large number of plants in the Southern States, where the main areas of low-income farmers are located.

Do you think the future holds much opportunity for employment of rural people in rural areas, in nonfarming occupations—in service industries and manufacturing plants such as Sylvania's?

Mr. **Mitchell**. Yes, sir.

Mr. FRISCHKNECHT. And would you venture an opinion as to whether some of the folks leaving the farms today, or those that have left farms in the last decade, have been going into small rural industries?

Mr. MITCHELL. Certainly they have.

Mr. FRISCHKNECHT. Maybe that will answer the complaints critics of President Eisenhower's and Secretary Benson's farm program have been making that the Eisenhower farm program is driving farmers from the farms actually this migration has been going on for over 80 years.

Mr. MITCHELL. I would like to say the reason industry takes these small plants into these small towns is to combine the economic benefits of mass production with the social benefits of living in small communities, in contrast to large industrial centers, all in all, it is a case of setting up your plants in a balanced community with diversified industry, high community pride, and with a good atmosphere to get a good job done.

There is in some small towns some differentiation because living costs are smaller than in big cities.

Mr. FRISCHKNECHT. One more thing, the President and Secretary Benson have insisted upon is that we keep rural people in rural areas, if they want to remain. It is desirable to keep young people in that type of environment.

Mr. MITCHELL. That is right.

Mr. FRISCHKNECHT. I want to thank you very much, Mr. Mitchell, on behalf of Senator Watkins for your appearance here this morning.

The CHAIRMAN. Dr. Moore, would you like to ask a question?

Mr. MOORE. No. I think, however, that Mr. Mitchell has pointed to one thing that we oftentimes overlook; namely, the employment-giving possibilities of the auxiliary services that grow up in the wake of manufacturing and new products. When we talk about automation, we are a little inclined to think of the manufacturing process exclusively. We are inclined to forget or overlook the fact that, as in the case of television, there are literally thousands of local servicemen whose jobs depend upon the wide use of products of the automated machinery.

Mr. MITCHELL. That is right. When I pose the threat of a labor shortage in 1975 I am including that kind of labor, not just manufacturing labor—all the jobs.

The CHAIRMAN. Mr. Frischknecht asked you about permitting the low-income farmers to work at industrial plants, and compared that to Secretary Benson's program of permitting the industrial worker, or permitting the farmers to engage in industrial work, and supplement their incomes.

I believe you stated a while ago that where people work in your plant and also live on a farm, they are listed as industrial workers and not as farmers?

Mr. MITCHELL. I think most of those who work for us are so; yes, sir.

The CHAIRMAN. That would be in effect getting them out of the farming business into industry?

Mr. MITCHELL. I think that happened in more cases. They may stay farmers but don't show up in farm statistics.

The CHAIRMAN. I know Henry Ford advocated that many years ago when he started a factory in Michigan. And, he succeeded to some extent.

Mr. MITCHELL. It is not possible in very many instances to run your plant only during those months when he cannot farm? We have to run our plants through the year. We do these other things of starting at 7 o'clock and getting through at 3. He probably cannot be a full-time farmer from 3 until 8. His wife works.

The CHAIRMAN. It is a good thing in a farming community. All the members of the family are not farming. Some of them are working in your plant and some working on the farm. You draw your labor from around the surrounding countryside that way.

Mr. FRISCHKNECHT. Mr. Mitchell, what has happened is not that people are being driven from agriculture by the effects of farm policies, past or present, but that these people are voluntarily leaving agriculture because they are attracted by employment in a firm such as yours which offers more security, higher salaries, on a more sustained basis, with resulting higher levels of living; isn't that true?

Mr. MITCHELL. I agree with that. Farming is becoming a large-scale venture, too, to be profitable. I mean it isn't the large-scale farmer that is in tough straits financially. It is the small-scale farmer.

The CHAIRMAN. That is right; the family-type farmer.

Mr. MITCHELL. That is right; he is having a tough time.

The CHAIRMAN. Thank you very much, Mr. Mitchell. We appreciate your testimony. We know it will be helpful to us.

This afternoon we have Mr. Robert C. Tait, president of Stromberg-Carlson Division of General Dynamics Corp., and Mr. Howard Coughlin, president of the Office Employees International Union.

The subcommittee will stand in recess until 2 p. m. today.

(Whereupon, at 12:10 p. m., a recess was taken until 2 p. m. of the same day.)

AFTERNOON SESSION

The CHAIRMAN. The subcommittee will please come to order. We have as our first witness this afternoon Mr. Robert C. Tait.

My good friend, Frank Pace, executive vice president of General Dynamics Corp., tells me that the Stromberg-Carlson Division, under your leadership, Mr. Tait, has had considerable experience and is making great advances in the field of electronic controls, printed circuits, and automatic assembly.

When we first invited Mr. Pace to have a representative meet with the committee, we were particularly interested in knowing more about the development of and the expectations for the milling machine capable of producing prototype as well as production parts which the Convair Division of General Dynamics is reported to be building. While this is a little outside your Stromberg-Carlson Division, I know you will be able to add to our understanding of the industrial economic significance of all of these things, Mr. Tait.

We are delighted to have you. You may proceed in your own way.

STATEMENT OF ROBERT C. TAIT, PRESIDENT, STROMBERG-CARLSON CO.; SENIOR VICE PRESIDENT, GENERAL DYNAMICS CORP.

Mr. TAIT. Thank you, sir.

I will speak about the milling machine but in a little different way, if I may, because we have a milling machine project of our own. I would rather refer to that. The Convair division milling machine project is temporarily suspended. We have one covering the same thing.

Mr. name is Robert C. Tait, and I am president of Stromberg-Carlson Co. and a senior vice president of General Dynamics Corp. of which Stromberg-Carlson is now a division.

As you mentioned, Frank Pace is executive vice president of General Dynamics.

I suppose everyone who testifies in this hearing will first attempt to define what they conceive to be the meaning of the word "automation," and I hazard the guess that these definitions will vary widely. Some may limit the meaning of automation to a very restricted field and others to an extremely broad field. Only time will tell which is right. In my own view, automation is simply a phrase coined, I believe, by Del Harder of Ford Motor Co. in describing their recent supermechanization which represents an extension of technological progress beyond what has formerly been know as mechanization.

Some experts in this field limit the application of automation to control devices that involve what is known as feedback—that is, a system of machines and controls that is capable of adjusting its own operation in the direction needed to obtain a desired result, rather than simply following a preset cycle of operations. One of the earliest applications of the feedback principle is James Watt's flyball governor for steam engines. Other similar long-standing applications are windmills, ship-steering engines, thermostats, and so forth. Thus the feedback principle in itself is nothing new but the modern application is new in that the feedback information is handled by electronic means.

Perhaps these two charts, made up by our manager of automation research, and used recently in a talk he gave on this subject, may help to illustrate the difference between mechanization and automation as generally understood.

The CHAIRMAN. You can explain them for the record, please.

Mr. TAIT. A three-set chart in which mechanization is illustrated by having an automatic process here, whatever the process is, through which a product is machined, or in one way or another processed, is monitored, inspected, and brought out the other end. This is all run by some kind of a control. Let's say preset cams, in the case of automatic screw machines. Cams are set by some kind of an operator. They will run this thing through and the monitoring cam can be either automatic or human. If the monitoring is not accurate, and if the control is not accurate, this kind of process can run on making machine parts wrong indefinitely, because the cams are set wrong.

When you get into automation you have one more factor. The same automatic processing, a similar type of control, and automatic monitoring, so the product runs through here, subject to this control, but the monitor immediately feeds back, and this is what I call the

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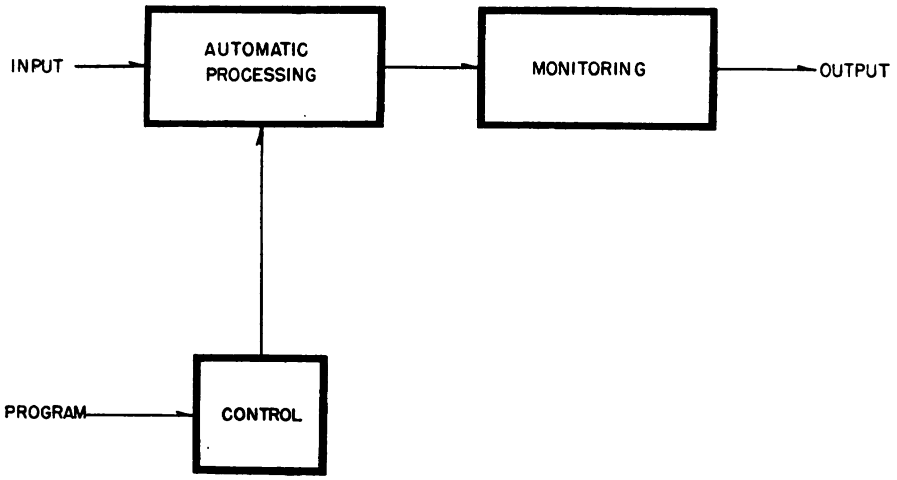
feedback, information with respect to the accuracy, and if it is off one way or the other this information is immediately given to the control, the control changes the machine operation to correct the variance, and keep the product coming out exactly as it should be.

This, I think, is very simple. It is a circle of operation, a very simple illustration of the difference between what we call mechanization and automation.

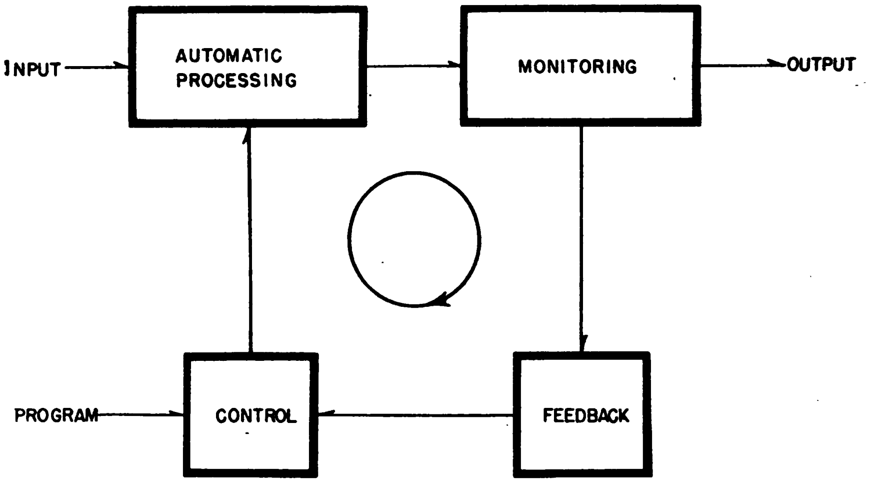
The CHAIRMAN. We will insert those in the record in connection with your remarks.

(The material referred to is as follows:)

MECHANIZATION



AUTOMATION



Mr. TAIT. I would like to spend just a minute on what we feel also are the major areas that may be affected by automation involving this feedback principle.

They appear to me to be the following: No. 1, an old one, continuous-flow process: This is probably the oldest area in which automation has been applied for years, principally in the oil and chemical industries.

No. 2, the multiple-tool application: This is the one that is sometimes referred to as Detroit automation, because it is best exemplified by the block-long machine systems that are operating in some of the automobile plants. Such multiple-tool systems are also operating in a number of other industries notably in metalworking and packaging. When such a system of machines performs many steps without human intervention, based on the feedback principle, it is generally referred to as automation. When it performs just a few functions on a preset pattern without employing the feedback principle it is really simply advanced mechanization. This supermechanization referred to as Detroit automation is obviously only economically justifiable in connection with the mass production of huge quantities, where the unit volume and value are high enough to amortize the extremely heavy initial capital investment in the required specialized machinery.

No. 3, numerical control: A good deal of work is now being done on the application of the feedback principle to individual machine tools in a manner to provide far greater flexibility than would apply in the Detroit supermechanization. This is a method whereby a machine tool is hooked up to an electronic computer or programer and instructions are fed to the machine by means of punchcards or magnetic tape. The input contains numerical instructions ordering the machine tool to move, let us say, one-thousandth of an inch in this direction or that direction.

This numerical control is the type of control that we refer to in this milling machine, and I will have a little bit more to say about how it operates.

The basic concept here is no more radical than the old-fashioned player piano, but the application of electronics to the system is new. Information is fed back to the electronic control, which automatically gives immediate instructions, and they are immediate, they are instantaneous, for correction of any variance. Machines can be made to perform automatically almost any normal machine operation under this principle.

We have a little engineering subsidiary in Los Angeles known as Electronic Control Systems, which is now working on what we consider to be a simpler method of programing information from the blueprint stage to the computer or programer than now exists under other methods so far as we know.

Suffice it to say here that this electronic method of applying numerical controls to the operation of machine tools appears to have a broad application to different types of machine tools and the operations to be performed by them.

No. 4, the automatic assembly of electronic components: This is a somewhat different application of automation whereby electronic components are automatically attached to printed wiring boards by a battery of special machines to which the components, capacitors, resistors and so forth, are fed. United Shoe Machinery and General Mills, and 1 or 2 other companies, have specialized in the development of these machines, and the automatic printed wiring board assembly is particularly adaptable to large-scale production of radio and television subassemblies.

No. 5, data processing: This field is comprised principally of computers from specialized types up to the big giant calculators such as Univac. These machines do mathematical jobs at unbelievable speeds, far beyond any human ability. Of course there are already any number of jobs that are now being handled electronically or mechanically that simply could not be done by human labor. You are all familiar enough with these.

There is no need in my taking time to enumerate a lot of them. There is an endless list of jobs now being performed by mechanical or electronical means that could not be done by human labor. Human labor isn't able to do that kind of a job.

They are not new. They are not revolutionary. They have been going on some time. For example, the red hot ingots, pourings, from a modern steel mill. The huge ladles, and so forth, with molten hot metal, couldn't be handled, certainly not in that size, by human labor, or with that speed. That has been going on a long time.

Of the foregoing five categories we are most interested in Nos. 3 and 4, the numerical control of machine tools, and the automatic assembly of electronic components. Our engineering group out in Los Angeles is also much interested in the last one which I referred to as data processing.

About a year ago at Stromberg-Carlson, we set up an automation research section headed by one of our ablest young men. Functions of this group were:

1. To advise top management with respect to developments in automation and their application to our particular products and manufacturing techniques.
2. To redesign products susceptible of automatic assembly or the application of other automation techniques in their manufacture.
3. To implement the introduction of automation techniques and assist in training the people involved in their use.
4. To maintain a liaison between ourselves and other divisions of General Dynamics Corp. as well as our own west coast operations, so that our processes and techniques will be compatible and coordinated into a general pattern.

Our automation research section was initially staffed with personnel drawn from various departments within the company that would be affected by their program. Our research department, engineering departments, production engineering departments, and production departments all had representation in the original section, and to this nucleus were added qualified personnel from outside the company.

The section was divided into three distinct groups, chemical, electrical, and mechanical, each with a supervisor. In addition to the people attached full time to the automation research section, personnel are called upon in other departments to lend a hand when necessary to implement a program as required. The work of the section is organized on a project basis. If a project is largely mechanical in nature it is assigned to the mechanical group; if electrical or electronic it is assigned to the electrical group, and so on. All projects are estimated as to cost and time schedule and are assigned numerical designations so that monthly financial statements can be issued according to our standard company procedures.

One of the first projects of our automation group was to redesign one of our conventionally produced portable radios to make it possible to assemble this radio by automatic insertion of most of the components onto a printed wiring board.

I think I should say a printed wiring board is simply a method of printing circuitry on a plastic or bakelite board so that the connections between the various points are all put in there automatically, instead of having a lot of wires. These are either photographically or mechanically produced in quantity and with the little canals of metal running around, that constitute the circuits. On to that printed wiring board are placed these resistors, capacitors, and other electronic components that are required in the construction of a radio or TV set, or other similar products—all kinds of electronic devices susceptible to that same kind of assembly.

We contracted for a series of United Shoe Machinery component assembly machines, and now have these in our plant set up for operation of this and other volume assembly products.

It is interesting in this connection to note, however, that the entire direct labor cost in a manually wired and assembled radio chassis of this type often constitutes less than 3 percent of the selling price of the set. This is the direct labor cost in relation to the sales price of, let's say, an ordinary radio—less than 3 percent of the selling price in most cases.

The major cost of the product is in the components, and redesign requirements for automation must not increase these costs by even a fraction of a cent or the possible labor savings are more than offset. In other words, it might reduce this 3-percent labor cost to 1½ percent. Even with fully automatic assembly to the extent of the techniques now known, it is not likely that this already minute labor cost will be reduced by more than half.

Another current project of our automation research group is the application of numerical control to machine tools of all types—I don't want to bore you with these, but want you to know about our operations.

The CHAIRMAN. It is very interesting.

Mr. TAIT. Is the application of numerical control to machine tools of all types, lathes, milling machines, boring mills, drilling and punching machines, spot welders, and so on, that I have already mentioned. Our automation research group is working with our west coast subsidiary, Electronic Control Systems, Inc., and some machine-tool manufacturers, to expedite the development of our electronically controlled milling machine and the application of similar electronic controls to other forms of machine tools.

If I may interrupt myself here, this milling machine is not unique as a machine. Any ordinary machine operation is subject to the same kind of control. The trick is the transferring of blueprint information into an electronic gadget that is in a sense a computer, in fact, largely a computer, that then can translate this information to the machine, get the feedback information, and immediately correct the machine, so that it can run a boring mill, or an ordinary mill, or a lathe, or punch press, or anything.

In general, we are studying two kinds of numerical control—all of this is called numerical control in the parlance of engineering—the first of which we refer to as path control, which is particularly suited to machining processes in which the cutting tool generates a curved or a straight line on a surface, as in the operation of lathes and milling machines.

The second type of numerical control might be described as discrete positioning—discrete being an engineering term meaning entirely separate and individual—discrete positioning is better suited to the operation of punch presses, drilling and broaching machines, spot welding, etc. This is the type of control that is required for transferring work processes from point to point, locating very quickly and accurately without regard to the traversed path between points.

You want to drill a hole or set of holes and move it over here and drill some more—that sort of thing.

Although all of our work in these fields is relatively recent, particularly in respect to the actual application of these automation techniques to our own production, it appears now that we are going to need all such new techniques in order to turn out the production that we think we see forthcoming in future. Actually, our employment in Stromberg-Carlson Co. plants in Rochester alone has more than doubled in the past 5 years.

I think the breadth of application of automation to the five major fields mentioned earlier, at the beginning of these remarks, gives some idea of the wide diversity of application and also supports the contention that the impact of such varied application cannot possibly be all at once.

In other words, automation is likely to affect different industries at different levels at different times. Actually, I am one who believes that it may be a lifesaver at this particular time in our history when we are facing a more rapid relative increase in total population over the next decade than in the work force, because as you all well know, the big increase in population during this coming decade is going to take place in the very young ages and in the over-65 ages, and not so much in the work-force ages.

General Electric Co. figures that by 1964 they will have to produce twice the volume of goods produced last year, with only 11 percent more people on its payroll. Adjusted for a probable decrease in working hours during this period, this next decade, this means that 10 years hence General Electric (and we are comparable in a way, only much, much smaller) must produce about twice as much for every hour of work per employee as they did last year. Automation in every conceivable direction, from blueprint to the shipping dock, is the only answer to this situation.

Carroll Boyce, associate editor of Factory magazine, has presented in an article entitled "What Automation Means to America" in last month's issue of Factory one of the most factual and realistic arguments I have yet seen in support of this thesis. He indicates that we face a labor shortage over the next 10 to 20 years rather than mass unemployment as a result of automation.

President Colbert, of Chrysler, recently said:

> Automation * * * multiplies man's ability to produce the goods for better living * * *. Only this advancing technique will make it possible to fill the needs of the American people for an ever-increasing quantity of goods to keep pace with our rising population.

May I also call attention to the fact that automation is being directed largely toward, and almost entirely, as a matter of fact, toward manufacturing processes, and manufacturing provides only about 30 percent of total employment, historically and presently, and likely to continue so in the future. In fact, it is likely perhaps to go down in total percentage of the whole.

As someone else put it, automation is about 90 percent emotion and 10 percent fact; and even if we applied all that we know about automatic controls, regardless of costs, only a small segment of the labor force would be affected.

It might be well also to mention right here that the rate of progress of automation has its own built-in feedback control, namely, the economics of whether the job that it might perform can pay its way out, for the capital investments in this field are going to be very high. Management can only justify them where the improved product or lowered cost, or combination of both, will repay the heavy initial capital investment over a reasonably short time.

It is strange how technological advance in whatever form has been resisted over the years. There's an 1830 cartoon on an office wall of General Electric that shows the dire disasters to be expected from the introduction of steam power in factories. It even goes so far as to recommend that mothers bear no more children, since the introduction of steam would take away any possibility of jobs for them.

In Belgium workers would slip off their wooden shoes or sabots and use them to jam the machinery which was going to deprive them of jobs. This, of course, was the origin of the word "sabotage."

And in France a so-called economist with a rather warped outlook introduced into the Chamber of Deputies a bill that would make it illegal to sharpen an ax. Dull axes would obviously make cutting down a tree more difficult, would require that much more labor, and thus provide more jobs.

Getting back to our own company, Stromberg-Carlson's biggest business—not generally understood by the public—is the telephone business, not radios and TV. The telephone business is by far our biggest business. We make complete dial systems, exchanges, instruments, and so forth, for the independent telephone industry, which comprises some 5,000 companies, giving service to almost two-thirds of the geographical area of our country. That again is something not generally understood by the public. The introduction of the dial telephone displaced large numbers of telephone operators who, you will recall, used to answer your phone, and maybe still do in your small towns, if any of you are from the small towns or the sticks somewhere—used to answer your phone with a pleasant "Number, please?" They are practically gone now. Yet, despite the terrific pace with which the telephone companies have been modernizing their plants and installing dial phones and automatic equipment, including now completely automatic and unattended toll-ticketing systems, there are more people—by far more people—employed by the telephone companies today than ever before.

Actually, I know of no specific case in which even these "Number, please?" girls, the ordinary switchboard girls, were displaced, even in a single company. They took them right into other jobs because the companies, as they mechanized, have grown so fast. True, there are fewer people per telephone, but there are millions more telephones, and there will be millions more than now. This is a typical American production story.

The introduction of new machinery and new instrumentation has never failed to increase the overall opportunity for more and better jobs. It is a simple mathematical process. Technology multiplies the amount of the goods per worker. The more goods the more cheaply they can be sold. The more cheaply they can be sold, the bigger the market they can find. The bigger the market, the more people that must be employed to fill the demand. (That I put in there parenthetically. It wasn't in the script.) It is a truism, I think, that is characteristic of our entire industrialization of this country and is going to continue to be in my judgment. Thus I think it is sound to predict that the impact of automation on our economy will be gradual and evolutionary rather than sudden and evolutionary. I repeat that we desperately need automation to maintain our standard of living with the onrush of our population, and in passing I would like to express the thought that we need be more concerned about the availability of human engineering talent than we need be about the impact of automation. We are really getting into a serious situation in this respect, for we are graduating far fewer engineers than our industry needs now, let alone the future.

Anything you gentlemen can do to stimulate our talented youth to go into engineering would be of great benefit to our country. Even if we persuaded twice as many qualified students to take up engineering in the future as are now entering these fields, it would take years before we could catch up with the shortage.

As is frequently the case with such complicated problems, I heard one man expound a very simple proposition the other day, that he feels contributes greatly to our engineering shortage. In these days of high educational costs, where thousands of students are trying to get the assistance of scholarships in one form or another, this man claims that the vast majority of them shy away from the exact sciences like math, physics, and chemistry because in these sciences you either know the answer or you don't; you are either right or wrong, and the teacher has no problem in determining which.

In the humanities, where a student can call on his imagination and at least make a bluff if he is not sure of the answer, he frequently gets by because it is much more difficult for the teacher to evaluate an imaginative answer. Then when such a student does get into college, if he has had no background in the sciences, it is too late to catch up.

This man claims we are losing thousands of engineers, potentially good engineers, simply because of this one simple little principle, and I am inclined to think he is right. I would like to see that corrected. Sorry to digress here, sir, but I wanted to mention this subject that I feel is of greater importance to the future of our country than concern about the impact of automation.

An excellent closing statement to my remarks would be Philip Murray's well-known statement on the effect of technology on unemployment in the United States, made several years ago when he was president of CIO. I am sure it will come up several times during these hearings, but I am advised it has not yet, and if so it bears repeating. Quoting Philip Murray some years back when he was president of CIO, he said:

> I do not know of a single solitary instance where a great technological gain has taken place in the United States of America that has actually thrown people out of work. I do not know of it, I am not aware of it, because the industrial

revolution that has taken place in the United States in the past 25 years has brought into the employment field an additional 20 million people.

The CHAIRMAN. That is a very interesting quotation.

On page 10 you mentioned about the shortage of engineers. I was told down at Austin, Tex., the other day, that every graduate of the A. & M. College of Texas this year was offered an average of seven jobs. They think the shortage will continue, as you suggest here, for a long period of time.

Mr. TAIT. I think it is accelerating at a very rapid pace because the need for engineering talent is increasing, and I think will increase in multiples as we go forward.

Incidentally, across the water, the bear of which we are so frightened, is turning out more engineers now than we are.

I think it is a very serious problem. I think this fellow's little idea about scholarships and the exact sciences has something to it. A premium might be given.

The CHAIRMAN. It works the same way.

Mr. TAIT. A premium might be given for boys that, properly screened, show talent for sciences that would get us back on the track, because we are going to need them. On the very subject of automation that we are discussing, we will require a higher degree of skills than in the past, and many more engineers, but I think we will also require more people than ever before.

The CHAIRMAN. Have you given consideration to selecting students, say, in high school, who demonstrate that they are intelligent and sincere and would like to do something in life, although they do not have the finances to go through college, to subsidize them in some way?

Mr. TAIT. Yes, sir, we are doing that, and most companies that need engineers are doing it. It is about the only thing we can do. We are also donating, contributing to higher education as much as we can possibly afford. It constitutes the biggest item in our contributions, outside of the community chest, it is the next biggest, and it is rapidly becoming an almost equal amount for educational institutions. We attempt to get lads in from high school who become interested in electronics or communication, and if they become interested in us, try to steer them into scholarships that we have already set up.

The university must retain control of these scholarships, but if the lad can qualify, he will generally come back. That is no assurance that we can keep him, but all industry, other companies, feel the same as we, that it is for the good of the whole even if we can't keep them later.

Some of the big ones, GE, and General Motors, and others, go to some colleges and say, "We will take your entire graduating class, no screening or anything. We will take every graduate." That makes it a little hard for some of us smaller companies.

The CHAIRMAN. How low on the school level do they go?

Mr. TAIT. Those are college graduates. We will take—and other people do it—we will take summer students, the ones under 18 that get parental consent for a little work in the summer. Generally they are 18 years old who have the right to work. If they like that type of work, we may be able to persuade them to go to engineering.

The CHAIRMAN. Under our system, which of course is the right system, there is no way of committing them to stay with you, just like the DP's that come over here.

Mr. TAIT. There shouldn't be.

The CHAIRMAN. No. I say that we all agree that it is the right system. Even the displaced persons that come over here, sometimes they kind of just hop, skip, and jump and don't stay very long where they are supposed to stay. There is nothing we can do about it, and we are not complaining about it, and for the same reason there is no way of committing these students. We don't believe in human slavery. We don't believe in tying human beings down. We expect them to take advantage of opportunities as they are presented.

Mr. TAIT. If I may comment, I think our system, which is right, will ultimately correct this, but it can be corrected much more rapidly with some outside help. The way our system I think would correct it—and it is taking place now—is that the engineering shortage will put such a premium on themselves that they will get paid more than other people, and as their pay gets above other people, more lads taking a look at what is coming will go into engineering.

The CHAIRMAN. That is true in your industry because they are trained.

Mr. TAIT. That is a long-time cycle.

Mr. Moore, would you like to ask any questions?

Mr. MOORE. Mr. Tait, am I correct in my understanding that you are not an engineer yourself?

Mr. TAIT. That is correct. I probably ought to be in this business.

Mr. MOORE. But your case demonstrates that, happily, there are opportunities for other than engineers in this automation world.

Mr. TAIT. Oh, yes. I didn't mean to gainsay that.

Mr. MOORE. In speaking of numerical control would you comment on how big a run of a model or a gadget is necessary to be economical or justify turning to an expensive, special-use machine?

Mr. TAIT. It depends entirely, sir—the answer to that depends entirely on the value of the article and the value of the machine operation.

Mr. MOORE. Are advanced automated machines or techniques necessarily mass-production instruments?

Mr. TAIT. No. A numerically controlled milling machine could almost do job-shop work, if it is the type of work that can be set up, and programed, and where it has a reasonable run. You couldn't do 5 of these and 2 of these and 1 of these, but you could do a hundred of them and another hundred of these, depending again on the relative value. It could be that you could do 5 of these more economically on a numerically controlled machine than 5 manually, if the application is complicated and takes so many man-hours of adjustment. It depends on the value of the product and operation.

Our automation section has come up with some very interesting charts. I haven't them here, unfortunately; I didn't think of them. But they are very interesting charts on the length of run of different types of operations, where the break-even point would make it worth while to have it numerically controlled rather than manually controlled, and the size of run is surprisingly low.

Mr. MOORE. Would a chart like that be intelligible to the layman so that you could put it in the record?

Mr. TAIT. Sure. I will have these sent in for the record.

(The material referred to appears at the end of Mr. Tait's testimony.)

Mr. MOORE. We hear a great deal, or it seems to be implicit in the thinking of many people, that automation necessarily means mass, continuous production. I gathered that the striking thing about this Convair milling machine was its adaptability to producing prototype. But you say that project has now been abandoned as such.

Mr. TAIT. The process Convair was working on was actually very similar to what we are doing in our electronic control systems, because this big skin mill for airplanes was for big airplanes. Although it might not be called mass production—a hundred airplanes is a mass production—it runs into millions of dollars, as you well know. The new jet bombers, as announced the other day, you read, ran over $5 million apiece, so a hundred of them is $500 million. A hundred units is not what we would conceive in our industry as any kind of production, but that is such a big operation, and so valuable, that a skin mill, a huge skin mill, for production of airplanes, even though they make only 100 or 50 or 25 parts, would save a lot of money.

Mr. MOORE. I have heard it said, and I wondered if you think there was any truth in the statement, that as a result of computing machines being able to handle the engineering calculations we had the DC-7 in production a year or two earlier than we might otherwise might have had.

Mr. TAIT. I think that is right. I am no more of an expert on that than I think you are, but I know it is true that in the amazingly complex mathematical calculations required in the design of aircraft computers are an invaluable asset, invaluable.

Mr. MOORE. In your statement you use the term "to redesign products." Do you have any examples in mind that you could cite of how a product has been redesigned to permit its production by automation? I have heard it said that in many cases we have items which by a slight redesign may be made susceptible to automatic machinery, but without the redesign they could not be.

Mr. TAIT. That is right.

Mr. MOORE. Do you have any examples of that?

Mr. TAIT. Yes; this little portable radio I speak of, the first article that we designed for automation, conventionally made, took capacitors, resistors, tubes, and connected with a complex system of wiring, and they are soldered together underneath a board or plate. To be automatic the insertion of these capacitors and resistors in the plate should be in certain places for efficiency, not just random around the place, and to permit the automatic machine to place them there.

Furthermore, the circuity should not be a whole mess of wires, but should be what we call a printed wiring board. These can be made photographically and etched or the circuity stamped out on these boards, so that the complete wiring assembly is right there on one piece of formica, or whatever it might be, an insulating material. You have to redesign that little product entirely in order to make it susceptible for automation.

Then it goes into a line of these machines and steps from one to another, picking up various components as it goes along. It comes out at the end all wired ready for soldering. It is automatically dipped and soldered, and all the connections are sealed in.

Up to this stage it has been almost entirely automatically assembled. The final assembly where they put in tubes and fit them into cases, is done by hand. Of course, somebody has to be around to run the machines, too, and they can turn out rather frightening quantities of product.

The Chairman. Well, Mr. Tait, it has been estimated by a number of witnesses that by 1965 we will have about 190 million people in this country. Assuming that we have that number, and that the country expands as it has expanded in the past, and as you anticipate it will expand in the future, what do you predict will be the length of the workweek by 1965, as compared to our 40 hours a week now?

Mr. Tait. I don't know that I ought to answer that. If I could tag that 1965 on it, because I have a bit of a situation—not a labor problem, thank goodness. We have no labor problem, I am proud to say. We have a union, a local, independent union, that we get along with beautifully. We have a bonus plan called the Scanlon plan of operation, that allows them to participate in the earnings derived from increased productivity. However, if I sit here and say publicly that I expect the workweek to drop from 40 to 30 or something of that kind I might get called up before I get home.

I don't think I can really intelligently give an answer.

The Chairman. I am not urging you to answer something that you I don't think I can really intelligently give an answer.

Mr. Tait. No; I think it will be a shorter week, though, perhaps 35—1965; Walter Reuther foresees a 4-day week, doesn't he?

The Chairman. Thirty-two-hour week, I believe he said, 4 days of 8 hours.

Mr. Tait. I think it will be not more than 35 or 36.

The Chairman. All right. Now, Do you have much installment buying in your business, or are you dependent upon installment buying to any great extent?

Mr. Tait. The answer is "Yes"; in the radio-TV business, installment buying is a very important factor. In the telephone business it isn't called installment buying, but we have a financing subsidiary which amounts to the same thing, whereby the telephone company really is a long-term installment purchaser, when they buy new dial equipment and modernize their plants. They will pay sometimes over a 20-year period, and many times they cannot get adequate financing for that length of time. So we have a financing subsidiary of our own.

The Chairman. But the ordinary consumer durable restrictions and limitations don't apply to that type financing, do they?

Mr. Tait. They do not. Actually, the safeguards surrounding such financing are stricter than they are on ordinary installment purchasing, because it is so long term.

The Chairman. Do you see any danger in the present level of installment buying, and the size of the aggregate installment debt?

Mr. Tait. No, I don't think it is any higher in relation to our total disposable income. In fact, our disposable income, that is the percentage of actual disposable income, is increasing rapidly and I think we will continue to increase very rapidly. By that I mean a narrower term than disposable income, which is really income after taxes; I mean discretionary disposable income that is left not only after you pay your taxes but your rent and your actual needs, your necessities, food and clothing; the surplus of discretionary spending income is increasing very rapidly, fantastically, and predictions indicate that over the next 10 years it will go up like that. In a situation like that, the gap is widened so that I wouldn't be concerned about the size, although it is huge, the size of the installment purchasing in this country.

The CHAIRMAN. Thank you very kindly, Mr. Tait. We appreciate your testimony.

(The information previously referred to follows:)

PARTS FABRICATION CONVENTIONAL OR NUMERICAL [1]

By H. S. Gleason, manager, Automation Research Division, Stromberg-Carlson Co.

Until very recently, there have been two basic conventional processes for fabricating metal and plastic parts. One process involves the use of standard machine tools, such as milling machines, lathes, and drill presses that are manually operated. The other process involves special machinery such as screw machines, turret lathes, forging, and diecasting machines. These machines require special tooling in the way of cams, templates, molds, and dies, and are often automatically or semiautomatically controlled. The selection of the most economical process for parts fabrication has been established primarily by the quantities involved.

Today, there is available a third process that is destined to have considerable influence on the economy of producing parts. This process involves the use of numerically controlled machine tools. These machines are directed in their activities by input media that directly involve neither manual manipulation nor cams, templates, dies, and the like. There is a distinct advantage in using these machines for certain types of work, and their development has progressed to the point where certain evaluations can be made, and areas for further development and standardization can be pointed out. Developments of the Arma Corp., General Electric Co., General Riveters, Inc., Hillyer Instrument Co., Hughes Aircraft Co., Lewis Flight Propulsion Laboratory, Massachusetts Institute of Technology, Stromberg-Carlson Co., and many others are quite notable.

In general automatically controlled machines can be classified either as digital (numerical) devices or analog devices. Both types have their merits. There is a decided emphasis on the digital types when product versatility and extreme accuracy is required. Further classification of these machines identifies them as either discrete address devices that allow independent displacements along the various axes of workpiece or tool motion or those that require coordinated displacements along the axes of motion. Classic examples of the former category are automatic drill presses and punch presses. Included in the later category are milling machines and lathes.

The input media for the machine control units take the form of magnetic tape, punched paper tape (both standard and nonstandard), punched cards, steel strips, photograph film, and the like. The drive systems involve the use of hydraulic, pneumatic, and electric prime movers.

Programing plays a very important part in directing the activities of these machines and is often a laborious process. In the digital or numerically controlled devices, programing involves methodizing, computing, coding, and preparation of input media. In analog devices, often only methodizing and preparation of input media are required.

Numerically controlled machines will often do certain types of work faster and more accurately than those which are manually controlled. However, there are certain limitations to these machines that prevent them from being a panacea for all types of production. They are relatively low production machines and cannot compete with automatic screw machines or diecasting machines when large production quantities are involved. On the other hand, where only 1 or 2 parts are involved, they are frequently uneconomical. So, in general, there is a limited range over which they are now effective.

Much of the work that can be done to extend the effective range of numerically controlled machine tools can be accomplished by reviewing the machines and control units themselves. Figure I shows a graphical representation of conventional manual fabricating times versus numerical control fabricating times[2] for different quantities of a core model. It can be seen that it would take fewer hours to produce one part using conventional techniques than by using numerical control. If more than two parts were to be made then it would be economical to us numerical control within certain limitations. The break-even point for numerical control is approximately 1.3 parts.

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[1] Adapted with illustrations from Automatic Control magazine.

Figures II and III are further examples of conventional manual fabricating times versus numerical control fabricating times. The intersection or break-even point for numerical control occurs after 19.3 and 7.2 parts are needed, respectively, if special tooling times is neglected.

The slopes of the curves are functions of the machining and set-up times, and of the dollar value and life of the equipment.

In the case of numerical control, the intersection of the curve with the ordinate axis is a function of programing time, and the time required to prepare holding pigs and fixtures for the workpieces. At present the basic machine tool value, the machining, fixture fabricating, and setup times are of almost optimum values. This means that the dollar value of the control equipment and the programing times are fertile areas for further development.

Figure IV shows the possible effect of such effort. A fictitious part, a base plate, has been assigned dollar values for different methods of manufacturing. Numerical control-A has been arbitrarily assigned a slope and ordinate intersect that is compatible with the art today. Conventional-C represents the cost of the part if no production tooling were used. Conventional-D indicates that considerable production tooling (molds) has been ordered and that perhaps some additional machining is necessary. In this particular case, there would be no necessity of considering numerical control, as both break-even points occur in the region of eight parts.

If we can decrease the dollar value of the control equipment and at the same time decrease the programing time, as compared with curve A, we will establish a new curve B. The assignment of values for this curve is again arbitrary, but the effect is to allow a certain economy in producing parts by numerical control. In this particular case, numerical control would be effective for quantities of parts from 4 to 18. It can be seen that the reduction of programing time will allow smaller quantities of parts to be machined economically. Decreasing control equipment cost will extend the production range.

Several things can be done to decrease the slope and ordinate intersect of the hypothetical curve A:

(1) Making the control equipment at each machine tool less intelligent, less complex, and with elements of standardization, will reduce its initial cost and hence, influence the slope of A.

(2) Special purpose machinery will make programing simpler, and can serve a multitude of machine tools and their associated controls.

(3) Methodizing for repetitious parameters can be standardized and filed.

Not all of the things that can be done to extend the effective range concern the design of machine tools or the control units. Starting right from the beginning, the parts should be designed and specified in terms that are commensurate with the fabricating or production process. Electronic equipment designers have already felt the impact of automatic assembly equipment. This equipment will not tolerate design and layouts that have been so common in the past. Television and radio sets are now being designed to fit new manufacturing processes that not only increase the quality of the merchandise, but also reduce its cost.

Most of the organizations that are involved in numerically controlled machine tools are taking steps to increase their effective range. It should be recognized that this field is expanding at a rapid pace. No unnecessary impediments should be placed in the way of this progression. It might be well, however, from time to time, to take real cognizance of their practical values. Industry is aware of the importance of these machines and stands ready to use them.

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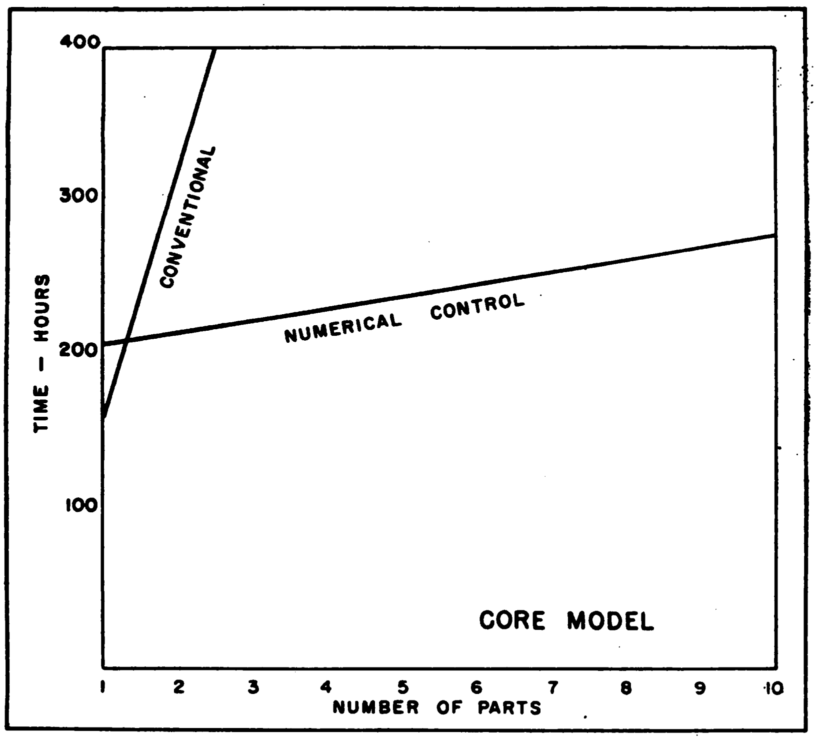
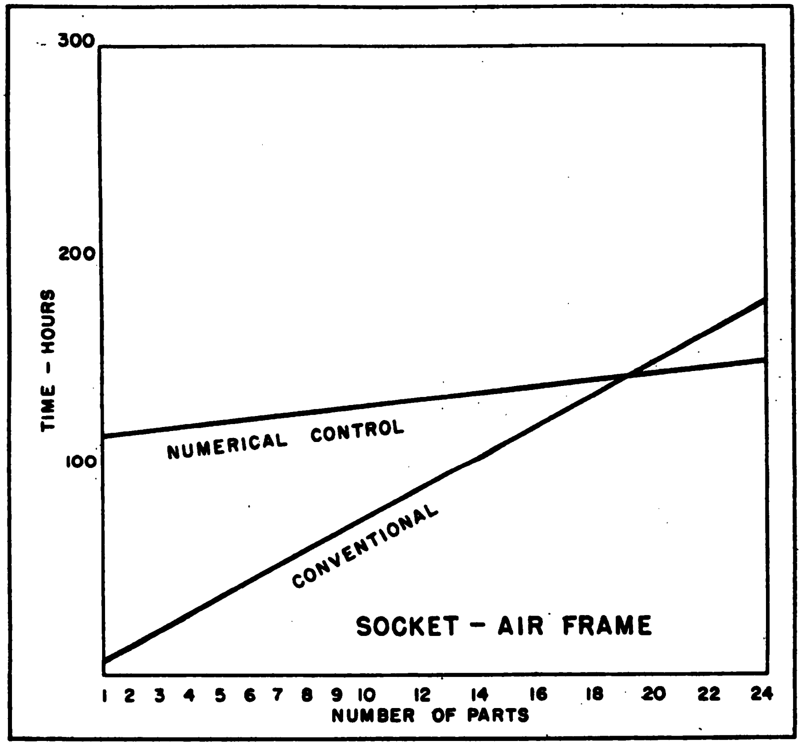
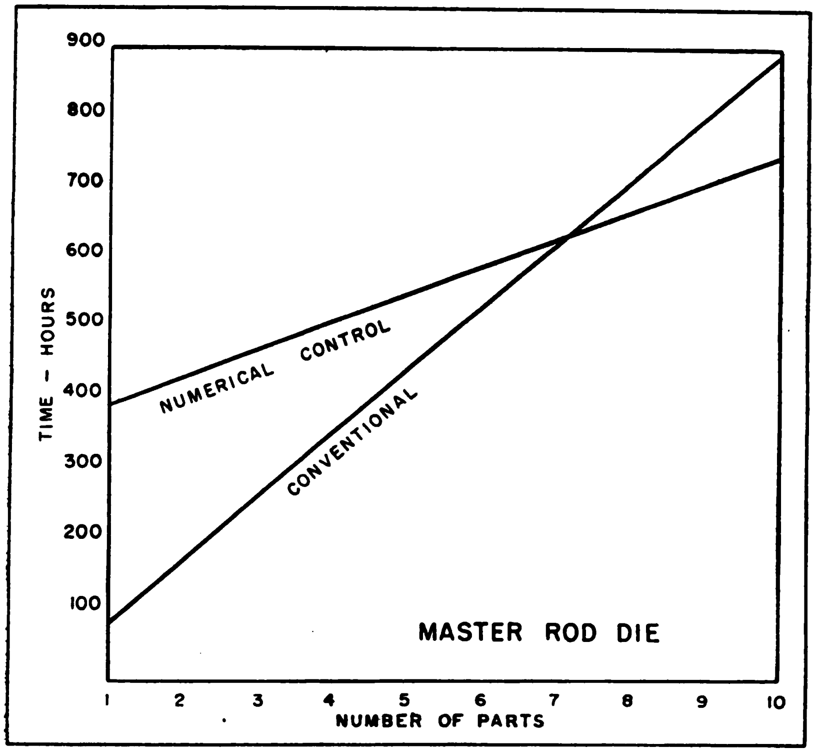
[2] Adapted from data of MIT Servomechanisms Laboratory, September 1954.



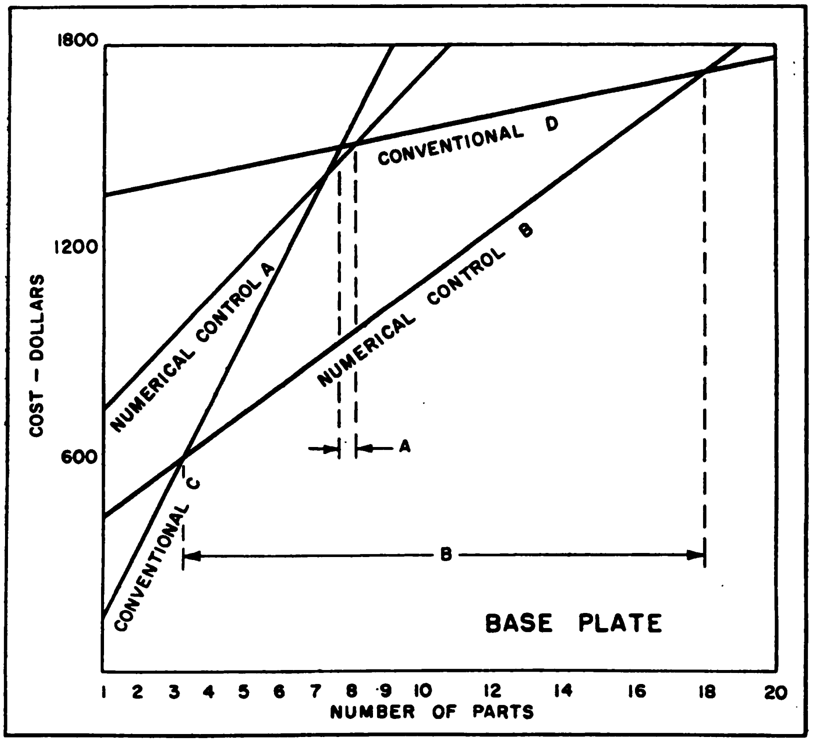
If a single part is being made conventional methods are best. Data from MIT Servo Lab.



Break even point for air frame socket fabrication lies between 19 and 20 parts.



When over seven parts are used in master rod die, more can be made by numerical control.



Comparison of numerical and conventional techniques on a cost basis. See text for data.

The Chairman. Mr. Coughlin.

As president of the Office Employees International Union, A. F. of L., your appearance here ought to remind us of a fact which I think is often overlooked. Office work, like factory work, is continuously undergoing technological change. From the day of the quill pen, and the ledger clerk on the high stool, to the wide use of calculating machines and punchcards there has been change until we are now witnessing the installation of large-scale computing systems. Some of the insurance companies are now handling their premium calculations and their reserve accounting on these high-speed, thinking machines. The big utility companies, similarly, are mechanizing the whole billing process. We are interested in knowing what your thinking is about the effect of these new and advanced machines upon the position of office workers.

We are glad to have you, and you may proceed as you desire.

STATEMENT OF HOWARD COUGHLIN, PRESIDENT, OFFICE EMPLOYEES INTERNATIONAL UNION, AFL

Mr. Coughlin. Thank you, Mr. Chairman.

Automation in the office consists of the development of general and special purpose computing machines capable of recording and storing information, and of performing both simple and complex mathematical operations on such information. It is apparent that in the long run, automation will be of benefit to all of us. However, through the development of automation, dislocations of personnel will occur which will present many problems to be resolved.

Most experts on automation agree that electronic displacement of humans will go farthest and fastest in the office. During World War II, a shortage of clerical help was created. It was expected that at the end of the war this shortage would be replaced by a huge surplus of clerical personnel. The reverse was true. Instead of a surplus, the shortage grew more severe.

During the war, the military and defense agencies acquired the bulk of office equipment manufactured. For a few years following the end of the war, industry, expecting that the peacetime economy would resolve the problems of shortage of clerical help, did little or nothing to make the office more efficient. When it became apparent that the shortage of good clerical workers was creating serious problems, industry began to think about it in earnest. Postwar models of office machinery were snapped up. Work simplification programs were initiated. Work measurement techniques were borrowed from the factory. Inservice training efforts were intensified. Still, the shortage persisted. In effect, therefore, businessmen found themselves running faster and faster merely to stay in the same place. The postwar boom in consumers' spending, the foreign aid programs, and our defense spending continued to tax the abilities of business to deliver products and services.

The inevitable increase in office work that accompanied the boom made the shortage even worse. Looking at the overall picture today we find that there is still a scarcity of competent clerical help. The future, however, would appear to be different.

In an article recently published in Collier's magazine, it was stated:

> The office of the future will be a relatively quiet place, but will also be terribly efficient * * * Machines do not need a coffee break * * * The nerve center of tomorrow's office will probably contain a fleet of machines tended by 3 or 4 people, with the machines doing all the paperwork. Stenographers, typists, stock clerks, filing clerks, and bookkeepers will have disappeared. Routine jobs will be comparatively scarce. If the prospect of such an office makes you feel uneasy, you will be sharing an almost universal feeling * * * Office employees are afraid of new machines because they may take their jobs away.

Actually, however, this has not happened to a large degree, as yet, but the future seems to hold a real fear of a large number of dislocations because of the installation of machines. It has been freely predicted that new sales records in business machines will be set and much of that gain will reflect the increased interest in automation of the office and the use of electronic data-processing machines.

These machines involve the use of paper tapes. These tapes make possible a great deal of automatic type of repetitive data as, for example, names, addresses, and discount rates on bills. They can be used within one office or can operate machines at distant points over teletypewriters or telegraph circuits. Paper tapes are produced as byproducts of various devices such as punched cards, typewriters, bookkeeping machines, etc. In addition to operating machines directly, they can be converted into punched cards.

We in the Office Employees International Union of the A. F. of L., are not afraid of the long-range effects of automation, but we are concerned with its immediate effects. It can be that automation over the years will eventually bring about the shorter workweek. As one writer puts it, it may eventually establish the 7-day weekend. However, we call your attention to the problems we can expect immediately as a result of the installation of automative equipment.

On Thursday, September 22, 1955, the New York Times published a picture of a 25-ton bank clerk named Erma. Erma is a brain and nerve system made up of the equivalent of 17,000 radio tubes and a million feet of electric wire. It is housed in a strategic spot to the paperwork for a whole group of bank branches in the California area. It has been installed by the Bank of America. Erma is capable of handling the bookkeeping details of 50,000 checking accounts every day. While it will handle the work of the bank's four branches in San Jose, it can keep the books of a dozen branches of average size. Erma sorts checks by reading magnetized numbers, credits individual accounts with deposits, and subtracts withdrawals. It accepts "stop" payments and "hold" orders, catches impending overdrawing of accounts, and keeps customers' balances always available. When a customer's monthly statement is required, the computer will figure the service charge and turn out a complete printed record of deposits, withdrawals, and balance for the month at the rate of 600 lines a minute. This speed will be increased. Nine operators will be required. Five will sit at a keyboard and feed incoming checks and deposit slips into the machine. Others will operate a check sorter and supervise details. If a customer writes a check at a store, for example, miles away from this particular machine, this check, along with hundreds of others, will find its way to Erma.

The customer's credit balance is stored in a magnetic drum which turns constantly at 33 revolutions a second. The drum will process the check and indicate the new balance or call the operator's attention to the fact that the customer has an overdraft. Incidentally, this memory drum is capable of storing 300,000 separate numbers.

The Bank of America has indicated that the machine will increase speed and efficiency but will not reduce the number of employees. The bank stated, however, that staff members freed by the machine will be assigned to other jobs to provide greater service for the bank's customers and the public. At the same time, the bank announced that 36 more machines will be built. It is apparent, therefore, that all employees displaced will not be reassigned to other work. The bank also indicated that Erma would cut by about 80 percent the time required to take care of checking accounts. If this time is translated into numbers of employees and multiplied by 36, the number of additional Ermas to be built, it can be easily understood that a large number of displacements will occur.

The bank may put into effect a system of attrition whereby it will not replace employees who leave, retire, or are discharged. Thereby, they may reduce their staff by a considerable number of employees without necessarily involving large-scale layoffs. Whether the number of employees working for the bank is cut through layoffs or through attrition, the cut will take place.

In a paper presented to the Industrial Relations Research Association at Detroit, Mr. Harold F. Craig, of Harvard Business School, outlined a case study involving a large unidentified insurance company. The commercial department of the home office of this company was engaged in paper communication by mail, with 7,000 agents operating their 200 branch offices in the field organization. The volume of paper flowing in and out of the department was considerable, numbering each workday an average of 36,600 standard forms and involving a dollar value of $2,459,000. The unit value of each transaction was comparatively small, but the total aggregate value involved necessitated a precise system of accounting control.

There were 539 people employed in the commercial department prior to the installation of automatic processes. Before converting to electromechanical methods, the clerks in one division had to sort and record manually 150,000 dividend notices per week. After the conversion, the detailed repetitive work of this function was done on machines, and the job of the clerks was either to control the accuracy of the work performed by the machines, or to operate the machines themselves. Some of the work in the department was still done manually, but most of the volume work, such as the sorting and recording of dividends, was done on the machines.

While this company did not introduce any of the better known giant equipment such as Erma or Univac, its introduction of automative equipment resulted in substantial reduction of personnel. In this department a reduction of 133 persons was achieved. Again in this instance the employer did not lay off the dislocated personnel. Instead, through attrition, the reduction was accomplished. Regardless of how it was accomplished, however, this is just another example of the fact that substantial reduction in personnel resulted from the introduction of automative machinery.

IBM's 701, Remington Rand's Univac, and electronic computers will revolutionize office work. It has been stated by an expert that

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computers in an office are going to be like bulldozers in the construction industry. Electronic computers are sometimes able to do a year's computation in a very few months. These computers can also make up the most complex payrolls, perform necessary accounting operations, and, with their own high-speed printing, run off a pay register and make out checks.

Insurance companies have already installed electronic machinery similar to Univac and IBM's 701. These machines bill customers for premiums, calculate agents' commissions, figure dividends, and work out all the necessary actuarial data. The Prudential Insurance Co. figures that electronic computers will replace 60 to 75 other machines along with their operators. They figure to eliminate 200 of their personnel in 1 department alone. A utility company in the Midwest installed an IBM of the 700 series. The company estimates that 280 employees will be replaced by the operation of this machine. The machine is intended to receive a meter reading on a card fed into the machine. It will then calculate the difference from the previous reading, compute it at the present rate, store the present reading, and prepare a completed bill for the customer.

Both the IBM 701 and Univac can be used in the highly complex work of inventory control. Univac has been assigned to this task in General Electric's major appliance division at Louisville, Ky. According to an official of the company, Univac operates in the following way:

> If a decision is made to increase the production of appliances from 1,000 to 2,000 per day, Univac, within the matter of hours, will be able to show the effect on every item of inventory. To do this same job manually, one part of total manufacturing planning often requires up to 3 weeks or longer to accomplish.

Clerical employment in this country has been rising steadily since the year 1900. At that time 1 clerical worker was required to handle the paperwork of 30 factory workers. By 1940 this paperwork required handling by eight clerical employees. This increase took place despite the fact that a lot of labor-saving machinery was installed in offices, such as typewriters, dictating machines, duplicators, bookkeeping machines, and so forth. All of these devices had one thing in common. Their primary purpose was to help business carry on certain specific office operations more efficiently. They did not provide revolutionary new means of getting many different office jobs done simultaneously. This is the difference between mechanization and automation. Automative electronic equipment is designed to cut costs in the office. As a result, it will influence the number of employees retained in clerical employment. These machines are being sold on that basis.

The New York Times of September 21, 1955, quoted Mr. Fred M. Farwell, of New York, president of the Underwood Corp., as follows in a speech before regional company managers from 16 different cities:

> Meeting after meeting of such groups as the Office Management Association and the American Management Association have stressed reduction of office costs. They usually arrive at office automation as the answer.

Mr. Farwell predicted that within a few years companies would receive data from branch offices on perforated tape, feed the statistics to a machine, and receive up-to-date computations on which to base decisions. "The company which uses stale figures will be left behind," he said.

The American Management Association and the Office Management Association are stressing reduction of office costs. The makers of automative equipment are stressing the savings to be gained through the use of such equipment. Therefore, we can safely assume that in the future this equipment will cut down considerably the number of office and clerical employees working in the offices of our country.

I do not subscribe to the view that dire things lie ahead. We have had automation in our factories for some years without disastrous results. I do believe, however, that there will be serious problems caused by the introduction of automation in offices. Many individuals who have spent their lives acquiring certain skills and have come to believe implicitly in their own indispensability, are in for a rude shock. They will see machines do in seconds work that takes them days and weeks to accomplish. They will see machines replace the jobs they and their coworkers have come to feel are their permanent niches in the office world. A lot of people will lose their jobs. A lot of individuals will be forced to acquire new skills. There will be many new responsibilities placed on the employers of our country.

Our union, as a collective-bargaining policy, is insisting on bump-back provisions in layoff clauses. That is, we are demanding that employees who have been promoted from one job to another up the scale within the company will be given the right to bump back in accordance with their seniority and qualifications. Before that occurs, however, we are providing that such individuals, if displaced by virtue of the introduction of electronic equipment, be given opportunity to train for the automative job.

We are also providing that retraining programs be part and parcel of the company's policy. In the event of permanent termination, we are asking for and receiving a liberal severance-pay program. Through collective bargaining we can protect our membership who are touched by the introduction of electronic equipment. In unorganized offices there is no such protection.

We call upon the employers in the United States to conform to the practices instituted in our organization for the protection of persons displaced from office positions as a result of the introduction of automation. We feel that responsible employers should, as a matter of policy, insure the transition to automation without hardship to the office workers of America. We further urge employers to share with labor the gains in productivity resulting from automation.

The CHAIRMAN. We appreciate your good statement, Mr. Coughlin.

You have heard the estimates that have been made about our population 10 years from now, 1965, and about the economy continuing to expand. What do you predict will be the workweek at that time?

Mr. COUGHLIN. I very definitely agree with Walter Reuther that a shorter workweek will be the eventual result, and that we will eventually go on a 4-day week.

Incidentally, I was quite sympathetic to the previous person who testified, in his refusal to make such a statement in view of the fact that he had a union to deal with.

The CHAIRMAN. What are the principal industries that your workers are engaged in?

Mr. COUGHLIN. We are engaged in practically all types of manufacturing. We also are engaged in many of the service industries. We are not highly successful in insurance or the banking field. Up to the present date, the extent of unionization in the offices of our country have been mostly along the liens of following the success of other organizations, such as the large manufacturing-type unions.

The CHAIRMAN. And automotive and different types like that?

Mr. COUGHLIN. That is right.

The CHAIRMAN. Thank you very much. We appreciate your testimony. It will be helpful to us, I know.

The committee will stand in recess until next Monday at 10 a. m. in this room.

(Whereupon, at 3:20 p. m., the committee recessed until 10 a. m., Monday, October 24, 1955.)

AUTOMATION AND TECHNOLOGICAL CHANGE

MONDAY, OCTOBER 24, 1955

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC STABILIZATION OF THE
JOINT COMMITTEE ON THE ECONOMIC REPORT,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Wright Patman, chairman, presiding.

Present: Representative Wright Patman, chairman of the subcommittee, Senator Ralph E. Flanders.

Also present: Staff Economist William H. Moore; Staff Director Grover W. Ensley.

The CHAIRMAN. The subcommittee will please come to order.

Mr. James B. Carey is our witness at this time.

The industry with which your union, Mr. Carey, is associated, that is, the electrical industry, is in rather a unique place in this field of automation, as I see it. In the first place, much of the automation equipment, or at least important parts of it, used in other plants such as auto, chemical, and office work, is built by your industry. At the same time, since yours is a big industry with big-industry, mass productions volume, you are also feeling the impact of new automatic equipment being put in to help build this automatic equipment. You are to an increasing extent producing automation equipment; are you not?

Mr. CAREY. Yes, sir.

The CHAIRMAN. Mr. Carey, we are looking forward to hearing you. You may proceed in your own way.

STATEMENT OF JAMES B. CAREY, SECRETARY-TREASURER, CIO, AND PRESIDENT, INTERNATIONAL UNION OF ELECTRICAL WORKERS, ACCOMPANIED BY NAT GOLDFINGER, ASSOCIATE DIRECTOR OF RESEARCH, CIO

Mr. CAREY. Chairman Patman and members of the subcommittee, I am accompanied by Nat Goldfinger who will assist me in explaining the charts that I have.

I am James B. Carey, secretary-treasurer of the Congress of Industrial Organizations, and president of the International Union of Electrical Workers, CIO.

I appreciate this opportunity to appear before you today, and I should like to congratulate the joint committee for holding these hearings on the social and economic implications of automation.

First, I think that we should define our terms. There has already been too much nonsense expressed on this subject at these hearings, and elsewhere—about automation being nothing new, that it is merely continued mechanization, and that it will have no disrupting effect upon our society.

When I speak of automation, I am referring to the use of mechanical and electronic devices, rather than human workers, to regulate and control the operation of machines. In that sense, automation represents something radically different from the mere extension of mechanization. Of course, it is not a sudden, full-blown appearance. It rests upon previous developments, especially upon Government-sponsored research and development in electronics and radar. But it is a new departure from the older methods of machine production by machine operators, since it represents the automatic operation of machines and of entire industrial and clerical processes.

The first industrial revolution, usually identified with Watt's steam engine, replaced animal and human muscle power with steam power and electric power; it replaced the handicraft worker with the machine tender or machine operator. Automation uses control devices that result in the automatic production and processing of goods and data; it tends to replace the human regulation and control of machines and thereby changes the machine operator into a supervisor of an automatically controlled operating system.

Automation is a new technology, arising from electronics and electrical engineering. It is not a new machine, or even a new industry. It is rather, a new and revolutionary technology that is applicable to almost all, if not all, types of industrial and clerical operations. It makes possible the automatic office, as well as the automatic factory. There is a likelihood that entire departments, offices, and plants, in the major parts of the economy will be using automation equipment within the coming 10 years.

I am the president of the union whose members are at the center of this second industrial revolution. The members of the International Union of Electrical Workers produce the electronic equipment, the electrical machinery, and electronic computers that make automation possible. Furthermore, the members of IUE–CIO work in an industry in which automation has already been introduced, an industry that is being rapidly automated.

The problem before us is not whether we are for or against automation. This new technology is already here and is growing by leaps and bounds. The problem is whether or not the American people and our free society will be subjected to vast dislocations during the coming 10 to 20 years, when the automatic operation of many industrial and clerical processes will be introduced.

The CIO welcomes technological change since it makes possible improvements in living conditions and increases in leisure. For that reason we have welcomed the development of automation. But we know that improvements in living conditions, a shorter workweek, longer vacations, earlier retirement, and all the great promises of automation will not come automatically. Industry, labor, and Government will have to plan for these achievements and will have to work for them.

Technological change always has some degree of social and economic impact. Rapid technological changes in the past brought vast social and economic dislocations, witness the social dislocations and the ruthless exploitation and grinding poverty of millions of men, women, and children in Great Britain during the introduction of powered machinery and factory production. Or witness the near-catastrophe that befell us in our own country in the 1930's because we failed to adjust our economy and society to the introduction of mass production techniques in the 1920's.

Technological change almost always means labor displacement. It almost always means greater output at reduced costs of production. That is a major reason why companies engage in technological research and invest in new machines and in new production techniques. The new machines and new techniques of automation, now being introduced, are labor-saving and probably capital-saving, as well; greater output per man-hour of work and greater output per unit of capital investment.

Automation is being introduced in industry and commerce at the same time that great advances are being made in more conventional, routine machine operations. In combination, automation and routine improvements in mechanization are already speeding up man-hour output and reducing unit production costs to an extent that would have been undreamed of only 15 years ago.

With the widespread introduction of automation in the coming decade, and the continuation of routine improvements in mechanization, the rate of productivity increases will accelerate. And in the offing are further revolutionary changes in technology—the use of nuclear power and possibly of solar energy for industrial and commercial purposes.

Rapid technological change and the resulting sharp increases in man-hour output must be accompanied by rapid increases in consumer purchasing power. Only if consumers have the buying power to purchase the rising output of goods and services made available by the new technology will we be able to maintain high levels of employment nationally. The alternative is mounting unemployment, since an expanding volume of production, without rapidly growing markets, means inevitable depression.

But there is no assurance whatsoever that mass consumer markets will grow fast enough to absorb rapidly rising output. What is required is that organized labor be strong and effective, that industry accept collective bargaining in good faith, that business share the benefits of rising productivity with consumers through reduced prices, that Government tax and general economic policies be aimed at maintaining growing consumer markets and high levels of employment.

It is essential that we maintain high national levels of employment to minimize and localize the social and economic dislocations of the introduction of automation. But high national levels of employment will not altogether eliminate the problems. The introduction of the new technology will mean countless problems for individual workers whose skills are outdated, for older workers who are displaced and cannot find new jobs, for entire communities whose plants move to new areas, for small business concerns that cannot compete against automated giants.

It is morally and economically wrong to expect the working people of America to bear the entire burden of the social costs of introducing automation.

If business is going to benefit from the introduction of automation, then business should assume some share of the social costs—in retraining workers, for example, or in assisting families to move to new areas from communities in which plants have been shut down.

If society is going to benefit from the introduction of automation, then society, through the Government, should assume some share of the responsibility, by such measures as a vast improvement of educational and vocational training facilities, the opportunity of early retirement under the Social Security Act, and assistance to distressed communities.

I can assure you that organized labor will do all in its power to see to it that working people are not compelled to bear the entire burden of such social dislocations, that both industry and Government assume some degree of responsibility for minimizing the disruptions connected with the introduction of automation and for assisting those who may be left stranded during the transition to the new technology.

EMPLOYMENT IN THE ELECTRICAL MANUFACTURING INDUSTRY

You have already heard much about the electrical manufacturing industry, in which automation equipment is produced. You have been told that this industry has doubled in size in the recent past and will double in size again in the next few years. You have been told, too, that the electrical manufacturing industry will expand so rapidly as to absorb workers who are displaced from their jobs in other industries. I am sorry to say that these statements are a combination of partial truths and nonsense.

The electrical manufacturing industry has been expanding, true enough. Within a short period of time its production and sales have doubled. Its profits and dividends make it most attractive for wealthy investors. But employment has crawled ahead merely at a snail's pace.

You have heard a number of Pollyanna optimists here, who have talked about the great expansion of this industry, but without reference to employment. They have preferred to hide behind generalities and sales promotion clichés. Let's look at the facts.

From 1947 through the first half of 1955, the output of goods in the electrical manufacturing industry, as a whole, soared 87 percent. But the total number of wage and salary employees in this industry rose only 20 percent in that period. In other words, production rose more than four times faster than total employment.

How was this astonishing feat accomplished?—through rapid improvements in routine mechanization and the early introduction of automation within the industry.

During this period of time, 1947 through the first half of 1955, the number of production workers alone in the electrical manufacturing industry increased only 14 percent, while production rose 87 percent. Output soared almost six times faster than the number of production workers.

Employment of nonproduction workers, however, increased 40 percent, indicating, in part, the rising importance of professional engineering employees and the growing number of clerical employees. But automation, as will be shown later, will cut clerical employment drastically in the years ahead.

Electrical machinery production and warkers in the industry, comparison 1947–55

	Electrical machinery production index [1]	All wage and salary employees in the industry	Production workers in the industry	Nonproduction employees in the industry
1st half 1955	189	1,102,600	805,600	297,000
1947	101	918,000	706,000	212,000
Percent increase	87	20	14	40

[1] 1947–49=100.

Source: Federal Reserve Board and Bureau of Labor Statistics.

Mr. GOLDFINGER. This table indicates that the industrial production index of the Federal Reserve Board, as applied to the electrical manufacturing industry, increased 87 percent from 1947, through the first 6 months of 1955. In that same period, the total number of wage and salary employees in that industry increased 20 percent. The total number of production workers alone increased 14 percent, while the number of nonproduction workers in the industry increased 40 percent.

Mr. CAREY. The record, therefore, is truly one of spectacular growth of production for the electrical manufacturing industry. But employment merely inched forward.

How do these figures for the industry, as a whole, check with developments in its fast-growing electronics division, that produces radios, television, and electronic equipment? Here is what a Department of Labor study on the electronics industry reports:

> Electronics output in 1952 was 275 percent higher than in 1947 but was produced by only 40 percent more workers * * *.
>
> Output per man-hour (in the electronics industry) may rise even faster during the next few years as a result of improvements in manufacturing techniques. * * * These trends toward automation may result in the greatest reduction in unit man-hours in the industry's history during the next few years.

If we take one of the industry's major corporations, as an example, we find the same pattern of development—soaring levels of production, sales, and profits. On that basis, the Westinghouse Corp. could appear here and tell us that it had grown 73 to 99 percent in 7 years, between 1947 and 1954, and that would be the truth for sales and profits. But its total number of employees, nonproduction as well as production workers, increased only 15 percent in those 7 years.

Westinghouse Electric Corp.

	Products and services sold	Net profits after taxes	All employees
1954	$1,631,045,000	$84,594,000	117,143
1947	$821,254,000	$48,806,000	102,065
Percent increase	99	73	15

Source: Standard & Poor's.

Mr. GOLDFINGER. Standard & Poor's record for the Westinghouse Corp. for 1947 to 1954 shows a 99-percent increase in the dollar value of products and services sold, a 73-percent increase in net profits after taxes, but only a 15-percent increase in total employment of production, as well as nonproduction workers.

Mr. Carey. The phenomenal growth of Westinghouse, and of the electrical manufacturing industry generally, has meant spectacular increases in production, sales, and profits. It should be underscored here that the Government has subsidized a good part of this growth—through accelerated depreciation of much of its new facilities, the purchase of a large percentage of its output, the cost of much of the basic research, and the training of many of its key scientific personnel. But the remarkable progress of this partially Government-subsidized industry has not been accompanied by anything like an equally spectacular growth of employment. The sharp expansion of this industry's output, in the past decade of increasing mechanization and the beginnings of automation, has meant merely a slow rise in total employment and an even slower increase of production-worker employment.

THE IMPACT OF THE BEGINNINGS OF AUTOMATION, 1953–55

The considerable lag of employment, in the past 8 years, behind soaring output in the electrical manufacturing industry, and in its rapidly growing electronics division as well, is a broad indication of the impact of improving mechanization and the early beginnings of automation. But it has been only in the past 2 or 3 years that automated equipment has taken root in parts of the industry.

A more direct indication of the impact of the beginnings of automotion—and of continued improvements in mechanization—can be seen from an examination of employment in the past 2 years. Let us look at employment trends from 1953 through the first half of 1955, with production at high levels in both periods.

In the electrical manufacturing industry as a whole, the total number of wage and salary employees declined 9 percent between 1953 and the first half of 1955. Even more significant is the 13 percent decline in production-worker employment, in that period, while the number of nonproduction employees increased only 1 percent.

The beginnings of automation in the electrical manufacturing industry have helped to cut the employment of production workers, while the employment of professional and clerical employees has moved up slightly. But the spread of automation in the offices will cut the manpower requirements for clerical operations within the next few years.

When we examine employment trends in the electrical manufacturing industry's major divisions, in the past 2 years, we find the same pattern—a decline of total employment, a sharp cut in the employment of production workers and relatively stable or slightly increasing employment of nonproduction workers.

In the division of the industry that produces electrical generators, transmitters, distributors, and electrical industrial apparatus, the number of production workers declined 11 percent and nonproduction workers by 2 percent.

In the electrical appliance division of the industry, production-worker employment fell 13 percent, while nonproduction-worker employment increased 2 percent.

The number of production workers in the electric-lamp division of the industry declined 7 percent and the number of nonproduction workers remained the same.

In the industry's communication equipment division, that produces radios, television, and electronic equipment, the number of production workers fell 16 percent, while nonproduction employment increased 3 percent.

In the production of miscellaneous electrical products, the number of production workers declined 12 percent, and the employment of nonproduction workers increased 4 percent.

Mr. GOLDFINGER. The table that follows, from the Bureau of Labor Statistics employment figures, indicates what has happened to employment in the industry between 1953 and the first half of 1955.

In the electrical machinery industry, which is a broad category of electrical manufacturing, and in its major subdivisions, there has been a decline of total wage and salary employment, a greater decline in production-worker employment, and either a small decline or slight increase in employment of nonproduction workers.

Electrical manufacturing employment declines, despite high level output, 1953–55

	All wage and salary employees	Production workers in the industry	Nonproduction workers in the industry
ELECTRICAL MACHINERY INDUSTRY			
1st half 1955	1,102,600	805,600	297,000
1953	1,219,800	925,100	294,700
Percent change	−9	−13	+1
ELECTRICAL GENERATING, INDUSTRIAL APPARATUS, ETC.			
1st half 1955	369,500	259,800	109,700
1953	402,800	290,700	112,100
Percent change	−8	−11	−2
ELECTRICAL APPLIANCES			
1st half 1955	64,500	51,600	12,900
1953	70,800	59,000	11,800
Percent change	−9	−13	+9
ELECTRIC LAMPS			
1st half 1955	25,700	22,300	3,400
1953	27,600	24,200	3,400
Percent change	−7	−7	0
COMMUNICATION EQUIPMENT			
1st half 1955	493,800	354,000	139,800
1953	556,000	419,900	136,100
Percent change	−11	−16	+3
MISCELLANEOUS ELECTRICAL PRODUCTS			
1st half 1955	45,400	33,600	11,800
1953	49,500	38,100	11,400
Percent change	−8	−12	+4

Source: Bureau of Labor Statistics.

Mr. CAREY. If we examine the record of the Westinghouse Corp., for example, we find a similar pattern of employment trends.

In 1954, Westinghouse sales were $48,998,000 greater than in 1953. With the added help of the elimination of the excess profits tax, the corporation's net profits, after taxes, were $10,271,000 greater than in the previous year. But the corporation's total employment declined 5,586 from 1953 to 1954.

Mr. GOLDFINGER. The following table on the Westinghouse Electric Corp., from Standard & Poor's, indicates that the dollar value of products and services sold increased almost $49 million from 1953 to 1954. Net profits after taxes increased over $10 million in that period, while total employment in the corporation decreased 5,586.

Westinghouse Electric Corp.

	Products and services sold	Net profits after taxes	All employees
1954	$1, 631, 045, 000	$84, 594, 000	117, 143
1953	1, 582, 047, 000	74, 323, 000	122, 729
Total	+48, 998, 000	+10, 271, 000	−5, 586

Source: Standard & Poor's.

Mr. CAREY. The pattern of employment trends in the electrical manufacturing industry in the past several years is clear, I think, from the record. Manpower requirements per unit of output in this industry are being reduced sharply as a result of continued improvements in mechanization and the increasing spread of automation. Manpower output is rising at spectacular rates. Total employment, under these conditions, can, at best, merely lag far behind rapidly rising output.

During the past 2 years, production levels in the industry and its various divisions did not rise enough to prevent a decline in total employment throughout the industry. It now takes very sharp increases in production to bring about even a slight increase in employment.

Furthermore, increased mechanization and the beginnings of automation in factory production, in the past 2 years, have meant rapidly rising productivity of industrial production and the impact of displacement on production workers. Clerical employees in the industry have not yet felt much of the impact of automation. This will occur within the next few years.

The combined effect of improving mechanization and the spread of both factory and office automation, in the coming years, will mean even sharper increases in the industry's productivity than at present. Total employment of both production and nonproduction workers will lag even further behind rising output levels. In the 8 years from 1947 through the first half of 1955, it took an 87-percent increase in output to raise the industry's employment by 20 percent; in the coming 8 years, it may require a 150-percent increase in output to achieve a further 20-percent increase in employment. It will take accelerating rates of increases in output to maintain total employment, let alone to raise employment in the industry.

I do not wish to be misinterpreted here. I am not saying that the industry's total employment will not increase in the coming years. Of this, we cannot be sure. Some divisions of the industry will probably increase employment—those divisions whose output will soar. (But soaring output of automation equipment will mean labor displacement in other industries.)

Employment in other branches of the industry may fall—where output declines or fails to rise fast enough. I think we can be certain, however, that employment in the electrical manufacturing industry—the industry that is basic to automation—will rise in the next few years, only if output soars at an accelerating rate, faster than the industry's sharply rising man-hour output.

We cannot and must not depend on this industry to supply any large share of the needed job opportunities for those who are displaced from other industries, as well as for the growing size of the labor force.

THE INCREASING USE OF FACTORY AUTOMATION

The electrical manufacturing industry is being rapidly automated. Look at any industry journal and you will find a succession of reports on the use of new automatic machines and new materials in the electrical manufacturing industry.

In its June 18, 1955 issue, Business Week reported on the development of automatic assembly in the electronics industry:

> The newest switch—from hand assembly to machine assembly of components onto a television or radio chassis—is having major repercussions in the electronics industry today. By the end of the year, according to one industry authority, assembly machines will be at work in three of the biggest TV-radio companies in the United States. By next year, machine assembly will be going strong. * * *
>
> Three years ago, a few companies took the first step when they stopped soldering by hand. A tank of molten solder took over the operation. * * *
>
> Then, about 2 years ago, etched wiring came along. Instead of connecting the components with many short pieces of wire, all of the wiring was etched—or "printed"—onto a board. Each component was fitted into its proper place on the board—by hand; then, by dip soldering, all of the components were attached to the etched wiring.
>
> This development is beginning to show up in sets now, as companies start displaying their 1956 models. * * *
>
> But the really big change—automatic assembly—is not yet far enough along to be found in most 1956 models. (Admiral Corp. is one exception. Insofar as this change goes, Admiral seems to be a few months ahead of the industry. About 75 percent of the circuity in the new models it introduced last week was assembled by automatic equipment.)
>
> The change to automatic assembly will begin to take shape in other plants later this year. * * *
>
> When you couple it with dip soldering and etched wiring, automatic assembly brings the industry close to fully automatic production. With a single machine, components are fitted into a chassis automatically. One such machine that is now in action can produce about 200,000 assemblies a month. In a minute, it can produce 20 assemblies; working by hand, a fairly fast assembly line would need about 20 minutes to match what this automatic machine can do in 1.

As a result, the production of automation equipment itself, as well as radios, television, and other electronic equipment, can now be produced automatically by automation.

General Mills has put on the market a fully automatic machine for the production of electronic equipment. Called Autofab, this new machine, it is said, will assemble, in a little over a minute, the same number of multiple-part electronic units that now takes one worker a full day to assemble. It requires only 2 workers and a supervisor, and has a capacity of more than 200,000 assemblies a month, operating 40 hours a week.

An automatic assembly machine, of this type, for assembling military radar sets, has been produced by General Mills for International Business Machines Corp., according to Business Week. General Mills says it has several other such machines under construction.

Automatic assembly machines have also been developed by Admiral and United Shoe Machine Corp. Many other automatic machines are in use or in the process of introduction in various parts of the electrical manufacturing industry.

The introduction of the printed circuit at the Philco plant in Sandusky, Ohio, resulted in the elimination of 25 percent of its employees on the soldering and wiring assembly line. Almost all companies in the lamp industry, especially Westinghouse and General Electric, have developed automatic machinery.

Motorola, Inc., according to the October 19, 1955, issue of the Wall Street Journal, has developed a new high-frequency transistor that can be made on a mass-production basis. A transistor is a tiny, durable electronic device that performs the same function as a vacuum tube, but requires much less power. Its widespread use, in the next 5 years, will replace the vacuum tube in most, if not all, electronic equipment.

Paul R. Galvin, president of Motorola, predicted that this mass-production transistor would "break the roadblock" of transistor use in television sets, in expensive home and car radios, and a wide range of military applications, including guided missiles, radar, and electronic plotting instruments.

Transistors are already used in hearing aids and portable radios. A Motorola executive said that within 3 years or so, it would be possible to start replacing vacuum tubes in standard consumer products with semiautomatically mass-produced transistors.

General Electric already mass produces a new high-frequency line of transistors for use in radio circuits.

In an address before the security analysts of San Francisco, N. R. Maines, senior industrial engineer of the Stanford Research Institute, said:

> * * * a dramatic testimonial to the value of automatic production (in the electronics industry) is indicated by consideration of manpower requirements when daily production rates are boosted to high levels. * * * Our study indicated that production of 4,000 assemblies per day would require about 200 employees if automatic techniques were used as compared with nearly 1,800 if conventional techniques were used. It must be recognized that these findings were based on consideration of only 1 electronic assembly—a 6-tube high-reliability piece of equipment. * * *
>
> * * * The techniques of automation present (electronics industry) management with unprecedented opportunities for large-volume production at lower costs. * * * It should encourage continuous operation because of the relatively low labor cost involved.

OFFICE AUTOMATION

Electronic equipment is already in use in various clerical operations. Its use is spreading and there are some observers who believe that automation's sharpest impact, in the coming 5 to 10 years, will be on office work.

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Electronic equipment is already used by many firms for the preparation of entire payrolls, inventory-control, the making of airline or railway reservations, and many other clerical operations.

The best-known example of office automation in the electrical manufacturing industry, at present, is the use of Univac by General Electric, in its Louisville, Ky., office. Univac prepares the payroll for the plant's work force of about 10,000. Univac will eventually be used to perform many other tasks which now employ a large force of white-collar employees—to compile sales records, prepare bills, make sales analyses, and schedule production.

The impact of automation on clerical employment can be seen from its use by the Census Bureau where 1 electronic computer, according to the Government agency, does the work of about 100 conventional tabulating machine operators. The Washington Star of October 17, 1955, reported:

> The world's largest electronic computing system was turned loose this morning on the Bureau of the Census' 1954 census of business.
>
> For the first time in the Bureau's history, the tabulations of the results of a full-scale national census are being done entirely automatically on the Bureau's two Univac machines which tabulate, check, edit, and correct the statistics.
>
> The giant machines, which cost well over $1.6 million, have been used before for various smaller projects, but never for a full-scale census.
>
> Officials at the Bureau say the machines have already made possible reductions of from 25 to 75 percent in costs of the smaller projects * * *.
>
> One machine, the Bureau says, does the work of about 100 conventional tabulating-machine operators * * *.

The October issue of Fortune contains an article entitled "The Coming Victory Over Paper," which reports on a completely automatic complex bookkeeping machine. The article states:

> One of the most portentous experiments in business history was in progress last month in San Jose, Calif. For nearly a decade, giant electronic computers have been talked of as the answer to the mountainous paperwork of modern commerce. But there has been a difficulty: most paperwork is composed, quite literally, of printed or written information on paper, and before a computer can work with invoices, bills of lading, or paychecks, all paper-borne data must be transferred to punchcards, recording tape, or computer keyboard. Last month, however, the Bank of America was field testing, through its San Jose branches, a revolutionary machine * * * which not only could handle all the records for 32,000 checking accounts but could also "read" its information directly off ordinary paper checks.

It is claimed that the entire operation of maintaining the records of the bank's 32,000 checking accounts can be performed by 1 such machine, operated by 9 persons—replacing up to 50 bookkeepers. Future models of this machine, it is reported, will be able to maintain records for 50,000 accounts.

The spread of automation equipment in office operations revolutionizes clerical processes, just as factory automation revolutionizes industrial operations. Office automation will probably become widespread within the next several years. And with its spread throughout the economy—including the electrical-manufacturing industry which produces the equipment—manpower requirements for clerical work will be cut sharply.

To an increasing extent, scores of bookkeepers, accountants, statistical clerks, typists, and other clerical workers will be replaced by electronic systems and by a few people who supervise the operations of such systems, and by technicians to maintain and repair them.

Clerical work forces will be cut drastically and the entire nature of jobs and clerical operations will be revolutionized.

GROWING MASS MARKETS NEEDED FOR HIGH EMPLOYMENT

With the rapid growth of output resulting from automation and increased mechanization, a rapid and continued growth of mass markets is essential if high national levels of employment are to be maintained. That means that consumer purchasing power must increase rapidly enough to enable market demands to grow, along with the rise in output.

Organized labor has made a significant contribution to the growth of mass markets. The unions will continue to work hard for continuing increases in wages and improvements in fringe benefits—to see to it that wage and salary earners obtain a fair share of the benefits of technological progress.

The union's tasks, in this endeavor, are not easy. Management resistance to effective union organization and to genuine collective bargaining is still widespread. Management resistance to justfiable wage increases is considerably stronger.

To take an example from the electrical-manufacturing industry, man-hour output in the Westinghouse Corp. plants has risen by some 50 percent since 1949. But the wages of Westinghouse workers have increased only 26 percent in that period, and it is worth much less than 26 percent in terms of real wages or its buying power, because of price rises since 1949.

The Government can contribute to a significant improvement—by helping to provide an atmosphere and environment that is friendly to collective bargaining. Pious speeches by some administration officials do not provide such an environment, when other administration officers and their assistants—such as the top officials of the Department of Commerce—are known to be antilabor and engage in antilabor activities. Furthermore, generalities do not provide an environment for genuine peaceful collective bargaining, when administration recommendations to top policy posts in Government agencies, like the National Labor Relations Board, include people who are known for their antilabor sentiments.

The Government can also provide an environment that makes possible the peaceful negotiation of wage increases and fringe benefits, along with the economy's rising productivity. I have heard the Secretary of the Treasury say much about the importance of investment; I do not remember his emphasis on the need for increasing wages and salaries or improving the incomes of farmers to provide rapidly growing markets.

If automation requires 1 worker in an operation, instead of 20, that worker deserves a substantial wage increase. Changes in job classifications and wage structures, under these conditions, are essential. But this worker's new wage—under an incentive wage plan or on a straight-time basis—will not be 20 times his previous wage. Will business take the lion's share of the benefits of technological progress, as it did in the 1920's, or will society receive a share?

Wage and salary increases are an important part of the answer. But if society, as a whole, is to receive the benefits of sharp increases in man-hour output, industry will have to share the benefits of technological progress with consumers through reduced prices.

A congressional study of the price policies of the Nation's dominant business organizations is long overdue. I think that a thorough investigation of the wage-price-profit-investment policies of businesses, with assets of $100 million and over, would be extremely helpful in providing business with an incentive to share the fruits of industrial progress with both workers and consumers.

The Government's tax policy is an essential part of the needed effort to provide rapidly growing mass markets. The tax structure must be reexamined and the tax burden on low- and middle-income families must be reduced.

Federal and State minimum-wage laws must be likewise improved, to increase statutory minimum wages and to extend coverage to workers who are not now protected by such legislation. The unemployment-compensation system, too, must be improved to improve the benefit structure of unemployment compensation throughout the Nation.

A reduced workweek can be an important shock absorber during the transition period to the widespread use of automation. Within the coming 10 years the length of the workweek must be reduced. Part of the benefits of rising man-hour output should be shared by business with the American people through an increase in leisure.

The 30- to 35-hour workweek, the 2½- to 3-day weekend, the 4-day workweek, and extended paid vacations, these should be our goals within the next decade.

The progressive reduction in the length of the workweek can be achieved in good part through collective bargaining. But the Fair Labor Standards Act and State laws will have to be amended to provide for a shorter workweek.

Trade-union strength and collective bargaining can do part of the job of bolstering and strengthening mass markets. Government assistance, however, is required. Above all, the Government must live up to its commitment under the Employment Act of 1946, through its policies and actions, to promote maximum employment, production, and purchasing power.

THE IMPACT OF AUTOMATION ON INDIVIDUAL WORKERS MUST BE MINIMIZED

Even if high levels of employment, nationally, are sustained through rapidly growing mass markets, the widespread introduction of automation in the next several years will create serious problems for many individual workers and their families.

The displacement of individual workers from their previous jobs will be an inevitable result of the introduction of automation equipment in factories and offices. Shock absorbers are essential to minimize the burden of technological change on such workers.

If their skills are outmoded by new automatic equipment it is the responsibility of the companies to retrain them for jobs in automated factories and offices. The cost of retraining such workers, and of maintaining their incomes while they are being retrained, should be considered a regular part of the investment cost of changing over to automation.

If the worker is 60 years of age, or older—or if he is too old to be retrained—he should be granted the opportunity of early retirement, at an adequate pension. This requires changes in the Social Security Act and in union-negotiated pension plans.

Although academic students of the social impact of automation speak about the raising of required skills in the long run, a major problem for the existing labor force is the possibility of attempts to dilute skills, downgrade job classifications and cut wages.

What happens, for example, to the payroll bookkeeper or accountant, who is replaced by an electronic computer? The employer may offer him a job as a statistical clerk, to assist in preparing data for the computer; the employer may also attempt to cut his salary.

The union will do all in its power to prevent such downgrading and wage cuts. But the employer has the responsibility of offering him an opportunity to retrain for a skilled job, and society has the responsibility to him, and to others in similar positions, to provide available educational and vocational facilities for retraining.

For workers who cannot find new jobs with their employers, substantial severance-pay provisions must be made by companies. Business does not have the moral right to displace workers who have invested years of their lives in the firm, without any provision at all for their future welfare.

Guaranteed wage plans are also essential to provide incomes for workers who may be unemployed for long periods of time as a result of the widespread introduction of automation.

Labor-management agreements will have to be revised to provide for changes in job classifications, job titles, wage structures, and seniority. The seniority provisions in contracts will have to be broadened, for example, to give displaced workers an opportunity to transfer their employment more easily, without loss of seniority rights. In multiplant companies, consideration should be given to the possibility of transfers from one plant to another.

Management, I think, has a duty to consult with the union before automatic equipment is installed, to plan for the inevitable changes, and to work out arrangements that will make such changes possible at a minimum cost to individual workers.

A great improvement in educational and vocational-training facilities is required. This is a necessity to help in the retraining of workers for responsibilities in automated plants and offices. It is essential for the education and training of young people in the new technology. As automation spreads there will be a need for an increasing number of engineers, technicians, and skilled workers.

With the increase in leisure, additional education and cultural facilities must also grow.

Our school system today is in need of vast improvements. Educational facilities will have to be expanded even further in the years ahead. Federal aid to education is essential to enable the States and localities to move forward, with speed, to expand our educational system.

The responsibility of providing shock absorbers to minimize the disruptive effects of the introduction of automation on individual workers belongs partly with industry and partly with Government. Industry must be prepared to bargain with organized labor, in good

faith, on these matters. Government must be prepared to fulfill its responsibilities in the field of human welfare.

DISTRESSED COMMUNITIES MUST BE ASSISTED

There are distressed communities in our Nation today. Although compaign promises to assist them were made by Republican candidates in 1952, such assistance has not yet been forthcoming.

In part, this localized distress is the result of declining industries or changes in raw materials. But, in part, it is the result of antilabor companies that have run away to new communities where wages are low and union organization is weak. The pirating of industry is not uncommon; some southern communities boast of their low wages and absence of union strength, and, furthermore, attempt to entice companies with special local-tax privileges. The Federal Government has also contributed to this problem through accelerated depreciation allowances for new plant facilities, without much thought to the social impact of new plant locations.

Automation will probably create many additional distressed communities. Companies may decide, and many have already decided, to close old plants or reduce their operations, and to build new automatic plants in new localities, leaving stranded large numbers of workers, local businesses, and community facilities. N. R. Maines, senior industrial engineer of Stanford Research Institute, said on August 17, 1954:

> The use of highly automatic machinery may permit plant location with major emphasis on accessibility to sources of supply and markets, and with minor emphasis on labor supply.

It may also be cheaper, from the business-profit viewpoint, to build a completely new automatic plant in a new area than to automate an old plant.

I am not opposed to the movement of industry when the reasons for such movement are based on sound economic and social foundations. But even, then, companies do not have the moral right to move out of town without any consideration at all for the old community, its workers, and local businesses. At a minimum such companies should offer workers an opportunity to work in the new plant at the same or higher wages, and should assist such workers in moving to the new area.

Government assistance for distressed areas is absolutely essential. There should be an attempt to place Government contracts with firms in such areas. Government should, likewise, assist the States and distressed communities in attracting new industry. Workers should receive Government assistance to move to new areas, if they have found new jobs in other communities.

While industry bears a direct responsibility for assistance in these cases, I think that the Government's responsibility must be underscored. All too often the Government has subsidized, at least in part, such moves to new areas, through accelerated depreciation under the tax laws, for example.

In the electrical manufacturing industry, we are unfortunately familiar with this problem. And we know that frequently the movement of plants and the selection of new locations are based on antisocial reasons.

Take the case of Westinghouse Corp. On November 30, 1951, Ralph Stuart, then a vice president of the corporation, wrote a letter to Members of Congress in which he attacked the administration of the Walsh-Healey Act, and threatened that Westinghouse expansion in the Southern States would be curtailed unless the company was permitted to establish a wage structure in its southern plants that was considerably lower than the wages paid to its northern workers.

What Mr. Stuart apparently wanted were starting rates of 60 cents an hour, and a progression to the statutory floor of 75 cents an hour, at a time when Westinghouse plants in New Jersey were paying newly hired, unskilled workers $1.25 and $1.27 an hour.

Not too long after Mr. Stuart wrote his letter, crippling amendments to the Walsh-Healey Act were proposed in the Senate, and one of these amendments was adopted.

There should be an end to the process of Government subsidies and assistance for plant movements in an attempt to exploit workers in the South and in other less industrialized areas that lack effective union strength.

The Fair Labor Standards Act and the Walsh-Healey Act should be strictly enforced throughout the Nation, without special privileges for companies that seek to pay low wages in nonunion communities. The Federal tax laws should not be used to subsidize any such migration of plants. And, where communities are left stranded, the Federal Government must move in to assist them and their unemployed workers.

Automation holds forth the promise of great advances in living conditions and leisure. But in the transition period to the new technology, during the coming 10 to 20 years, every possible effort must be made to minimize the dislocations that the introduction to automation will create.

There is no use in trying to avoid the problems that will accompany the widespread introduction of automation. And there are no built-in electronic devices that will automatically produce economic and social adjustments to the new technology. If we are to enjoy the fruits of automation in the period ahead we will have to use foresight and wisdom in overcoming its social and economic disruption and in minimizing the possible harm it can bring to countless individuals, communities, and small businesses.

Organized labor can and will play an important role in making these adjustments. To do so, however, will require that business bargain with unions in good faith. And business, too, will have to assume its share of the social costs of changing over to the new technology. In this effort, Government can provide the policies and many of the shock absorbers to help maintain high levels of employment and to minimize the possible social dislocations.

These hearings should be followed by a continuing study of the social and economic impact of automation, by the staff of the joint committee.

The effort to overcome the social dislocations that will accompany the introduction of automation should rise above partisan politics. If all of us, labor, business, and Government, combine to prevent social disruptions and human misery arising from the introduction of the new technology, we will be able to usher in a new era of abundance, improved living conditions, and increased leisure.

The CHAIRMAN. Thank you very much, Mr. Carey. Your statement has given us some very good information, which we appreciate.

The committee is honored this morning with the presence of one of the oldest members. I do not mean in age, but in length of service on the Joint Committee on the Economic Report. He is, of course, a very valuable member of that committee. Senator Flanders, of Vermont, in private life was in the machine-tool business himself. He was with the firm of Jones & Lampson Machine Co., of Springfield, Vt. I think he probably knows more about this particular subject than any other single Member of Congress. We are delighted to have you this morning, Senator Flanders. Since I have been interrogating the witnesses during your absence, I now yield to you to take up the entire time of interrogating this witness, if you wish.

Senator FLANDERS. Thank you, Mr. Chairman, I may say that while I have had experience with automation, it is not a broad experience. My experience deals primarily with machine tools, and to some extent with office machinery. However, within the limits of my experience I am glad to ask some questions.

Mr. Carey and I are old friends. We have discussed things before, both privately and publicly; I am glad of the opportunity to be with him again.

One question I would like to ask, Mr. Carey, is this: There was one industrial revolution which began about 50 years ago, and that was, so far as its application is concerned, what is commonly known as the introduction and rise of mass production. That is not to my mind the proper term for it. The proper term should be "continuous production." That is, to say every machine was (or is) set up for one operation alone, and is not regularly changed to some other operation. In other words, the work stream flows through continuously instead of in lots or batches.

That, of course, found its greatest exemplification in the automotive industry. I suspect we would all have to give Mr. Henry Ford, Sr., the credit for initiating it on a large scale.

Now, that was a tremendously important development. I wonder, Mr. Carey, if you would agree as to the importance and significance of that development?

Mr. CAREY. Tremendously, Senator. I think in fairness to Mr. Ford, we also ought to give him proper recognition for the fact that he knew or seemed to know that with the improved techniques that he termed mass production would have to come a shorter workday and would have to come improved wages. He was considered something of a radical in his day when talking about the 8-hour day and talking about the amount of pay that a worker should receive for those 8 hours.

Senator FLANDERS. You are quite right in that, according to my recollection. Certainly he started the rest of the manufacturing world with a notion that the worker should get at least $5 a day.

Mr. CAREY. Yes, sir.

Senator FLANDERS. That, of course, was 50 years ago. I speak of this because the question arises in my mind as to whether automation has any different effects, must we expect more severe problems, as it comes into common use, than we did from the introduction of mass or continuous production?

Mr. CAREY. The impact of automation will be far greater than that of the impact of continuous operation. The continuous operation arrangement eliminated or displaced some workers temporarily, but the automation displaces all workers, or almost all workers, from the operation of machines.

In that respect, it will have a greater impact. As one who left school in the year of 1929, right at the time of the depression, I would say that we did not take into consideration as a nation, or as a society, the impact of the mass production techniques on our society, and we felt the brunt of that and as a ressult we faced a serious depression.

The generation I am attached to didn't have the opportunities of previous generations in terms of getting employment. I cite you one example that perhaps we are both familiar with, Senator: We are talking of the electrical manufacturing industry. The second largest corporation in that field is Westinghouse and, of course, it is much larger than the company you are attached to, Jones & Lampson. Its major plant is in the East Pittsburgh area. It is almost the only large employer for many of those communities in that area.

During this present period of so-called prosperity and expansion in our industry, Westinghouse in East Pittsburgh does not employ production workers that have less than 13 years' seniority.

If you have less than 13 years' seniority in the Westinghouse plant—and this has been going on for several years—when the rest of the Nation had a larger measure of employment opportunities—you cannot even be on the waiting-for-hire list unless you have 9 years' seniority. There are 1,500 people on the waiting list, all of them having 9 years or more seniority. That situation is kind of a shocking thing.

Senator FLANDERS. If I read the recent news correctly, you are at present having differences of opinion with the Westinghouse Co.

Mr. CAREY. Yes, sir. There is a nationwide strike on.

Senator FLANDERS. You will excuse me then if I seem to sidestep that situation, and do not enter into it with my points of view that relate directly to it.

Mr. CAREY. Let us take a hypothetical case. Take now a case where there is an employer who is the only large employer in several communities. This example can be applied to the section of the country you are familiar with, Senator, New England. They are unable to employ their present manload, or what they have been having, due to the introduction of new methods. They can get greater output with less people. So they lay these people off. Where they are unionized they lay them off according to seniority rules, but the question arises in these communities, where will the people coming out of schools get employment? How can people, whether it is in Braddock, Pa., or in Springfield, Mass., or in Bridgeport, Conn., how can they get employment in these new modern industries like the electrical manufacturing industry.

These corporations are laying off people. If they rehire, they will have to rehire those who were laid off.

Senator FLANDERS.. Excuse me a minute. Are you suggesting that these depressed areas in New England, as an example, are depressed due to automation? I had supposed that most of those, at least those I know about, were depressed due to the shifting of the textile industry.

Mr. **Carey**. That is due to the increased mechanization. It is also due to Government subsidies, and to local tax subsidies. They can build more modern plants in remote communities.

Senator **Flanders**. That seems a related problem, but not immediately pertinent to the question of automation. We don't want to, or maybe we do want to, lay all of the fault for the depressed areas on automation. I am just trying to find out how serious it is now, however seriously it may be developing in the immediate future.

Mr. **Carey**. I am just simply suggesting that automation will aggravate the existing situation, and the timid steps that are taken to deal with the problem as it exists today will not be effective when you have added to this present situation a condition where you can build automatic plants in other communities cheaper than you can automate the plants that now exist in the old communities.

Senator **Flanders**. I understand; then you are speaking of a prospective danger from automation?

Mr. **Carey**. I am speaking of actual conditions, things that have already happened. Work going out of Pittsfield, Mass., down to Rome, Ga., work going out of New England into other areas, where they have more automatic plants, work going out of this East Pittsburgh plant of Westinghouse, going into low-wage areas. The Government has been so good to some of these companies that they have so many plants and facilities that are Government subsidized that they are giving away, as Westinghouse gave one of its new plants to the State of Arkansas. That is unfortunate, but it is a condition that exists.

Senator **Flanders**. It at least is a mixed condition in which automation plays its part, as you see it?

Mr. **Carey**. Yes, sir; the full impact of automation has not yet been felt, and when it is felt we are hoping that the Government will be ready, that business will be ready, that labor will be ready, and these communities. But I don't think we can ignore the fact that we have an obligation, with the experience we have had in our industry, to understand that it is a lot of nonsense to say that automation will immediately create additional jobs. That, to me, is a deliberate way of fooling the public and fooling our country.

Senator **Flanders**. Well, I wouldn't at the moment want to sustain as a general proposition the thesis that automation will increase jobs. But, I am thinking of the fact that the automotive industry took its great growth after continuous production was developed. I am wondering whether—and you would know this because you are intimately connected with the electrical industry—whether some of the things you mention here with relation to automation in, for example, production of television sets, and so forth, has not made for lower prices and the improvement of the production without raising prices possible in such degree that the general level of production and employment of the television industry has been on the whole not too unfavorable? Hasn't automation in the television industry, at least maintained employment rather than reducing it?

Mr. **Carey**. Oh, no, sir; that is the fallacy that this committee has heard time and time again—that all that is going to happen now is the same thing that happened when mass production techniques took over.

Senator **Flanders**. You say "all that is going to happen"—I am asking what has happened?

Mr. **Carey**. I say all that is happening now, and what is going to happen is not just a mere repetition of what happened in the automotive industry when the continuous production operations were introduced. This is going to be a different situation. The electronics industry that produces the automatic equipment is not moving up in employment opportunities as the automotive industry did. This is not just a displacement of a carriage trade with automobiles and trucks. We have some very interesting figures on this question, as it relates to this particular industry.

Senator **Flanders**. What you are saying then is that automation has already injured employment, for example, in the television industry?

Mr. **Carey**. Yes, sir; that the production in the television industry is soaring, and profits soar, but employment goes down. In the company where I was employed, just through the operation of 1 device in 1 plant, a dip-soldering process, you eliminate 25 percent of the workers on the soldering and wiring assembly line.

I might say this: They are now producing equipment to assemble on the chassis, through the use of printed circuits and other devices, on an automatic basis—2 people with a supervisor, with a man that is now in operation today, can displace 200 people.

Senator **Flanders**. What is the decrease in employment as compared with the increase in production in the television industry?

Mr. **Goldfinger**. I have that, Senator Flanders. These figures are from the September issue of the Federal Reserve Bulletin. The production index for radio and television sets indicates an increase of almost 2 percent between 1953 and the first half of 1955. In other words, a comparison between production in the year 1953 and in the first 6 months of 1955, shows an increase in the volume of production of radios and television sets of almost 2 percent. Now, in that very same period of time, according to the Bureau of Labor Statistics, there was an 11-percent decrease in total employment, total wage and salary employment, in the communications equipment branch of the electrical manufacturing industry.

Senator **Flanders**. Are those two categories identical?

Mr. **Goldfinger**. They are not strictly identical, Senator. This is one of the things that your committee can help us on, to get the identical figures. The communications equipment branch of the electrical manufacturing industry is the branch of the industry which produces radios and television sets, but it also produces other electronic equipment.

Let me finish these figures, though: Employment in this branch of the industry, which Mr. Carey's union represents, there was an 11-percent reduction in total wage and salary employment, in that period of time, and that breaks down as follows: A 16-percent reduction in the number of production workers, and a 3-percent reduction in the number of nonproduction workers, bringing it to a total of an 11-percent reduction in total wage and salary employment in that branch of the industry.

As I said before, that branch of the industry is the one that produces radio and television sets.

Senator **Flanders**. That is, in a way, an indication. Still, owing to the fact that the two categories are not identical, it is not as clearly defined as we would like to have seen it.

Mr. **Goldfinger**. No. That is certainly true. It is not as clearly and precisely defined as we would like to see the figures. I believe that perhaps your committee could asist all of us in getting more precise figures on what has been happening, but I think if you look through Mr. Carey's testimony you would find comparisons between the volume of production and the reduction in employment from 1953 through the first half of 1955 for various branches of the industry and for the Westinghouse Corp. You would also find comparisons between employment and the volume of production from 1947 through the first half of 1955.

Senator **Flanders**. Still speaking of the electrical industry, and your reference to the printed circuit—which in my definition of the word is not so much automation as a remarkable and ingenuous improvement in the design and manufacture of electrical assemblies—almost all companies in the lamp industry, especially Westinghouse and General Electric, have developed automatic machinery. Now, haven't those developments been going on before we ever heard the word "automation"?

Mr. **Carey**. Yes, sir; those developments have been going on, and that results in serious impacts on our whole society—some good, some were not good, because we didn't take into consideration what those impacts would be.

For instance, General Electric had a great part to play in developing the automatic production of a vacuum tube or a lamp but now, think, if you will, Senator, what happens when you have a tape that does the work of the supervision. It automatically can determine the production of this type item, it automatically measures the things, to see if they meet the requirements. It will reject them if they are not of the proper qualifications, and it will send it back to have it either repaired—automatically, without human hands touching it, or without the human mind being used in making these decisions.

This is a thinking machine that we now have, in addition to automatic, or the mechanized production. I think the printed circuit is part of the automatic procedure. I might say that I have seen whole companies wiped out. Sylvania Corp. has a plant for producing vacuum tubes in Puerto Rico; regardless of what excuse they use for closing down that plant, it was due to the development of the transistor. They trained people in Puerto Rico to do a certain kind of operation. Overnight that is wiped out by a new development, the transistor.

We are not opposed to the new development. We think it should be produced.

Senator **Flanders**. Just let me suggest that new developments in general are welcome and each one of them, if it is important, causes difficulty, but that has been doing so for a hundred years. The thing that interests us here this morning, as I understand it, is the special impact of what we have come to call automation.

By the way, Mr. Chairman, has Vannevar Bush appeared before you?

The **Chairman**. He will be here Friday, October 28.

Senator **Flanders**. I don't want to steal his thunder, but I will instead give him some thunder. I will say, that to my knowledge, the first automation was in the Waltham Watch Co., in Waltham, Mass., more than 50 years ago. I am reminded of it by your speaking of automatic inspection, rejection, and so forth. One of the items in that piece of automation was the introduction of a machine which received jewels from a magazine, calipered their diameter, made a recess in the end of the jewel screw to exactly fit that diameter, spun the edge of the jewel screw over and it passed on. In other words, the machine operated on the basis of measurements it had automatically taken on the jewels.

Mr. **Carey**. Senator, could I interpose something that I thought was rather remarkable?

Senator **Flanders**. Yes, sir.

Mr. **Carey**. Some of the best minds of our industry got together in a meeting in Schenectady, N. Y. I won't mention the name of the firm. They got together and they wanted to discuss the impact of automation on their own activity. They contended that they had not scratched the surface yet with regard to improved techniques, other than automation. They wanted to get ready.

One of these men presented a paper, apparently a well thoughtout paper, in which he said that if he and some of his associates had been there when God made the world, they would have shortened the time that he required for that purpose.

They went on to explain how they could have gotten it down to a 5-day operation, through the use of their techniques, and then he didn't stop there. He went on to explain how God had made another mistake, that he didn't provide the necessary data, in case we had occasion to make another world, and he said if he had been there with some of his associates, he would have made sure that we would have the data today, in the event we have the opportunity.

I think it is interesting. We are asking that those great minds be put to use in trying to develop some of the answers to some of these social and economic problems, that they helped to create, and I am suggesting here and now that we ought to require some solutions of American management.

I am raising questions here about some of the glib statements that some of these people make. They talk about the soaring operations—production, profits, and sales. I hope, Senator, that you, particularly, will ask some of these members of American industry what is happening to employment in this electronics industry.

You may have occasion to ask about what is happening in the lamp industry, as to whether or not the people that are making these items—now, it is true it is hard to relate. When you make transistors you sometimes don't know whether they are going into hearing devices or some other kind of equipment. They don't separate it out. Some of this equipment we make is used in the aircraft industry, it can be used in the automotive industry. I don't know how far we will go in this field. I am simply saying, some way, somehow, this Government ought to do something about it, as well as the employers and the unions in our industry.

Senator **Flanders**. Going back to Schenectady just a moment, you speak of the great minds. I would say that that man you mention must have one of the greatest minds of all history. I am surprised that he concerns himself with a little thing, if he is prepared to shorten the making of the world from 6 to 5 days. I am surprised that he bothers with a little thing such as automation. I hope there is something practical in what he said, instead of merely trying to be spectacular.

I would like to refer to office automation, because I have had some experience with that. I was surprised and disturbed in my own experience when office automation provided by a certain firm located in a southern tier of counties in New York State, whose name I will not mention, was introduced into the plant with which I had a connection before I came here.

I expected and hoped that office automation was going to reduce the number of officeworkers. Of course, that was a hardhearted position to take, but the business was growing and it wouldn't have decreased employment in any case. Instead of reducing employment, electronic equipment was so "slick" that they put on it 40 things they never thought of putting on before. There are now three times as many people in the office working with office automation than there were before we put it in.

I say "we" because it is an old habit. My connection with the company has dissolved but there is one case, at least, where automation did not result in unemployment. It resulted in fact in swollen employment. We came to know a lot more about what was going on than we did before, although perhaps we didn't know any more about what to do about it.

You have a paragraph in the middle of your remarks. What happens, for instance, to the payroll bookkeeper who is replaced by an electronic computer? I can tell you what happens. In the first place, the United States Government in its great wisdom keeps adding new deductions that have to be taken out of the payroll, and that man is still busy as ever. There are more people, as I said, in that bookkeeping department in Vermont than there were before the electronic computers were introduced.

That is not true of course in some of the extreme forms. That is true of the bookkeeping machinery in the case I mentioned, and with which I have a best acquaintance. It is less true, of course, with some of the purer electronic-computing apparatus, such, for instance, as is going into life-insurance companies. That is going to reduce the total number of clerks at work, unless the company is active and progressive and greatly increases the number of policies which it issues and sells.

Those are all the questions I have, Mr. Chairman. I just want to make an observation.

Referring again to this development of continuous production, it did result in the long run, thanks to the efficient negotiations of such labor unions as you represent, in shorter hours and higher wages. I would not be seriously surprised or disturbed if automation—in case automation turned out to be as large a factor as you think it will be, and of that I am not yet convinced, but willing to be convinced—I would not be disturbed if it made its contribution to shorter hours and higher wages, the same as continuous production did.

Mr. Carey. I join you in that, Senator, and I think it will result in some greater opportunities.

Senator FLANDERS. And at least no higher prices, because I am a pessimist, so far as prices ever going down.

Mr. CAREY. Prices can and should be much lower. I can cite the example of what the mass-production techniques did to the prices of, say, automobiles. Now in recent years, however, the prices have been going up when they should have been going down. Of course, you get more shiny equipment on a modern automobile than you did before, but that doesn't necessarily mean that we should eliminate the area of our market that we are eliminating by pricing the low-priced cars, what we normally consider low priced, too high. We should be having some low-priced cars as well as all the Cadillacs and the Fords and Chevys, that can no longer be put into the model T class.

I am fearful that the impact in the next 10 years on office work, clerical, bookkeepers, and others will be even greater than it will be in the production field and manufacturing, and I say that there will be less likelihood that the smaller companies that can't introduce the automatic methods in billing and invoicing, and other things, those smaller companies will be unable to compete with the larger giants.

They will be unable to introduce the newer methods as rapidly. In fact, they are rapidly becoming just subdivisions of the presently large corporations. That impact would be terrific.

Senator, I do hope some day that at least the staff of this committee will give some attention to the impact of automation on our cultural opportunities in this Nation. Not knowing too much about the field, but having worked at it, I could myself put together, with the knowledge that I have, the kind of instrument that RCA developed. It may sound sensational, but it is true that RCA can get an old recording of Caruso's voice and they can have Caruso singing bebop today, modern songs, just automatically, and they can reproduce any sound that can be reproduced on any instrument. You can take a factory noise and use that as the basis for music—singing, by human voices. Automation can have a tremendous impact in our cultural development in this Nation.

I do hope, Senator, that we can look perhaps at some of the figures that I have given here and some of the tables on the impact it has in our own industry, the industry that some people look to as gaining great benefits from the production of automatic devices. We can produce automatically automatic machinery that eliminates workers.

Senator FLANDERS. Excuse me just a minute. Did you ever read that book The Piano Player?

Mr. CAREY. No, sir.

Senator FLANDERS. Well, that is a fantastic book which indicates the final development of automation, in which the automation mechanisms are automatically produced, in which men are automatically calibrated, and automatically assigned to the duties they are to do. If you want to go further than our present knowledges goes—and you seem to be interested in doing that—I would suggest that you get hold of a copy of that book and read it.

Mr. CAREY. I will do that.

The CHAIRMAN. Thank you very much, Mr. Carey. I also want to thank you, Senator Flanders.

We have another witness before noon, and if the staff will forego asking questions, I will likewise.

Mr. Carey. Mr. Chairman, I will be available in the event that at some future time we can be of assistance to the members of the committee and the members of the staff.

The Chairman. Thank you very much, sir. We expect to have a continuing study.

Our next witness is Mr. William W. Barton.

Mr. Barton, I understand that your firm is one of those engaged in designing and building automated production lines. I gather that you made this special-purpose machinery partly by putting together standard lathes and drills produced by others, and partly by making the transfer elements in between, yourselves.

Your company is also credited with having an important part in the development of the widely discussed ordnance plant at Rockford, Ill. Later in these hearings we expect to hear from the United States Industries, Inc., the present contract operators of this plant. Between your knowledge of the construction of the plan and the present operator's knowledge, we should get a pretty good picture of automation in this well-known example.

We are, of course, even more interested in your views on the future development of automation in the automobile and metal industries. Mr. Barton, you may proceed with your statement in your own way.

STATEMENT OF WILLIAM W. BARTON, PRESIDENT, W. F. & JOHN BARNES CO., OF ROCKFORD, ILL.

Mr. Barton. Mr. Chairman, I appreciate and thank you for the opportunity to appear before your committee.

My name is William W. Barton. I am president of the W. F. & John Barton Co., of Rockford, Ill.

My company's primary products are special machine tools. Our customers are mainly the mass producing manufacturers of the country. We process, either "for them" or "with them," their parts. We suggest methods of manufacture, quote the cost of constructing the machines necessary to accomplish these requirements and estimate the rate of production that the machines will produce. Our company has been in the machine-tool field since 1872 and in the special machinery field since 1924. As such, Ishould say that we have always been active in promoting and developing automation.

While our line of special machine tools covers a range of operations, technically we confine ourselves to a rather narrow field in the industry.

For illustrations of our products I have included several of our brochures which I believe will suffice to indicate the general nature of our work.

With your indulgence, I would like to refer very briefly to the exhibits.

The first exhibit is a reprint from the February 1946 issue of Machinery, written by Mr. Oberg, covering some of the operations in the Rockford ordnance plant, and attached to the end of the brochure is a floor plan, together with photographs of the individual special machines created for that line.

The center section shows the floor-plan layout for the production of 155 millimeter shells, and the photographs have to do with the indicated operations, or some of them, in that line.

I will not take the committee's time to go in detail on the operations. It would take a great deal of time. I would like to do it, but I am sure that isnt' what you want. If you wish to study it, it is shown there.

(The material referred to appears at the end of Mr. Barton's testimony.)

The second brochure is a recent one put out by our company. It shows some of the intermediate operation transfer mechanisms that we have built. The first page shows an automatic probing device for a cylinder block. The bottom of the page is a carton caser and recaser which takes Quaker Oats cans out, puts them into the line to be filled, and then automatically repacks them in the case.

(The material referred to is available in the subcommittee files.)

Mr. BARTON. Following through are various storage conveyors and special machines of an assembly nature, and in the middle of the brochure we give some indication of the type of thought that must go into the automating of a production line.

At the end of that brochure, or very near the end, is a page showing the automatic transfer of crankshafts and assembled engines for balancing. The machines fit in the middle of these transfer mechanisms.

On the last page, we have a compound turn mechanism where the problem is to take a cylinder block and turn it 180° in one direction and 90° in another.

Following this brochure is a brochure covering an automatic cylinder head line. There are four such lines, as shown in the lefthand photograph of the second page of the brochure. These are the automatic lines for cylinder head production recently installed in the Plymouth Motor Car Co. They consist essentially of four machines, automated together. These four lines are operated and controled by operators that stand on platforms and watch the operations. The cylinder heads are automatically brought into one end of the line, as indicated by the arrow. They are automatically transferred from machine to machine, and they are put out at the end of the machine, completely finished and ready for assembly in an automobile. This, I assume, is the type of machine that you are interested in in the automobile industry. It is a gradual growth of many, many years, and of many mistakes and heartaches.

The next brochure is a brochure covering similar types of automatic machines that the industry calls, "progress through," or "transfer type" machines, that we have built for the automobile industry, and the tractor industry, for their cylinder blocks. The operations and the nature of the machines are indicated in the brochure.

(The material referred to is available in the subcommittee files.)

Mr. BARTON. Now, as these machines become more complicated you run into a little difficulty with maintenance. As one friend of mine told me recently, he had a plant employing 500 men, and his production was way behind. He could sell all the product he could get or produce, if he could only produce it faster and cheaper, he would be happy—he dreamed one night he made a plant that instead of employing 500 people and one maintenance man to run his plant—he put in a plant that employed one person, and then he had to hire 500 maintenance men.

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Now, while my example is facetious, it is to a certain degree true, so we have been forced to find ways and means of checking our electrical control and their interlocks, and the last two brochures cover an attempt of ours to systematize and automate, if you will, the checking of failures within the line, due to electrical misoperation. Similarly, or also in the last brochure, we show a number of other types of electrical control panels which we build, and on the bottom page, a rather complicated electronic cobalt teletherapy machine which we developed and built for the nuclear studies division of Oak Ridge.

Without taking further time, sir, to go into the specific explanation of all these machines, automation is a new word for a very old process. The trend of automation, I suppose, had its origin as far back almost as the invention of the wheel. Sometimes I wonder if the Athenian legislature may not have inquired into the economic implications of the advent of the harnessing of the energy of the wind. Did they inquire into the fate of all the galley slaves that the sail put out of work? I doubt if those replaced workers worried about losing their jobs as much as we see some of labor worrying today about the loss of theirs.

But, gentlemen, remember that the history of the effort of man is to harness and utilize more and more energy, and to replace by mechanical technocracy or automation the jobs of the galley slave so as to free him and his progeny from manual labor.

I could spend a week detailing examples of automation in various fields, such as the office, the telephone exchange, the kitchen, or others, or in exploration in greater detail examples of the machines and installations of our company.

All of this would add up to the conclusions that I am sure every witness that comes before you during these hearings will support, that is, that automation always has been with us and is the backbone of our economic progress. This conclusion is based upon the knowledge that, since the greater the total capital investment per worker the greater the productivity of any society—and the more a society has to divide the higher the standard of living. The degree of this advance is the measurement of society's economic progress.

I, therefore, inquire as to the definition of automation.

Harder, of Ford, who has been given credit for coining the word "automation," originally gave it a very narrow meaning, defining it as "handling of parts between successive production operations."

Peter F. Drucker, in his recent articles in Harper's Magazine which attracted so much attention, stated that—

> Economic progress might be defined as the process of continually obtaining more productivity for less money. The means to achieve this is innovation—the improvement in living standards is the result of innovation.

Then he goes on to state that innovation may be technological or nontechnological, and that the innovations that have had the greatest impact on our economy have been the nontechnological, such as our changes in distribution, our development of the new concepts of business organization, the new basic management tools such as controls of budgets, cost accounting, and production scheduling.

He defined automation as "the use of machines to run machines," and proceeded to explore the philosophical foundations thereof.

Norbert Wiener, the MIT mathematician, predicted that automation would lead to "the human use of human beings" and declared that "the automatic machine was the precise economic equivalent of slave labor."

Many others have incorrectly defined or spoken of automation as the second industrial revolution.

Carroll W. Boyce, in his article in the September copy of Factory, stated that—

> To most people, automation is just about anything that spells technological progress [or] if it means more production with less work, its automation.

As you all know, the article proceeded to outline what automation would mean to our economy. It was followed by comments by a dozen or so well-known men among whom was Senator Joseph C. O'Mahoney. And I believe Senator Flanders.

The October 1955 issue of Business Week, in an article on the subject finding so many divergent definitions, stated that it was "foolhardy to try to add still another." The article then proceeded to analyze some of the features and areas of application.

Personally, I prefer to think of automation in the larger sense—as an innovation created by man to increase his production; technocracy, if you will.

AUTOMATION'S APPLICATION

In a broad sense, it can be stated that any feat that hands and body can perform can be duplicated automatically, given enough time and money.

Too often recently those misguided individuals who fear the term "automation" and some of those who welcome it have left the impression that the trend is spontaneous and new.

Analyzing the application of automation under the impetus of the ever-faster pace to today's society, and studying the means with which it has been put to use in the past, we find one underlying fact, that automation does not just grow, nor is it, nor will it ever be, applied overnight to every activity of man. Were this possible, then automation should be greatly reverenced for we should suddenly have achieved that long looked-for utopia.

Automation's applications are a studied piecemeal process, created only after its need is recognized and measured and then only after its cost is weighted against that need.

Its creation is not a product of a moment or of one individual. Generally it is a result of years of effort, of trial and error, and the production of many creative minds employed to answer the question of how.

Sometimes the need is recognized and known to exist; yet the end product to satisfy that need can only be made commercially by this automation. I have with me a new type of tin can to exemplify this problem.

Gentlemen, for 3 years we have wanted to make this can. The can lid has got a little piece of wire built into it. We call this the zipper can, because you can take that little piece of wire, and if you are not careless you can pull it around like this and the can is open.

We made these cans. We cannot sell the tops because we cannot make the tops for the price that we can sell the tops, and we have only tried 3 years to make the machines to make the tops.

There is a lot of development work yet necessary. This is an imperfect problem, as you see. Furthermore, we cannot make it. It must be made automatically, with automatic machines. Successful automation could be referred to as the "accumulative correction of errors."

In our narrow field of the application of automation we never produce a machine or appliance that is not obsolete before it is shipped. Every machine we build can be improved upon and often is by our competition or customer. Every repeat order for a piece of automation produced by us can be bettered. The decision as to whether we try to do so or not is economic, a measure of the selling price, the cost, and the degree of success of the previous model.

AUTOMATION'S PRODUCTS AND BYPRODUCTS

The production of automation can only result in good for society as a whole, and it is gratifying to see that almost every article on the subject, including those written by the labor leaders, express this thought.

It is true that in the past many attacks have been made upon certain applications of automation, but never for long if the innovation truly freed man's hands and produced more goods with less work.

On the other hand, it is equally as axiomatic that the introduction of automation has and will create dislocations in the labor force—these may affect a few or many; they may be departmental wide, plant wide, or community wide.

It is also true that while upon the whole the result of automation will upgrade the vast majority of labor and make available more and more leisure time, that there will be those cases where, because of age or lack of will or mental inability, some will be downgraded.

But when a radio poll in Detroit showed that listeners feared automation next to Russia instead of welcoming it as the basis of the wellbeing of the city, the magnitude of the misapprehension and false fear of a large portion of our society is better understood.

This type of reaction is similar to the reaction of a large section of our society toward atomic energy. Only recently are the people of our country awakening to the human benefits of atomic energy, and then only after a great national effort to publicize the "atoms for peace" movement.

RESPONSIBILITY CREATED BY AUTOMATION

Accepting as facts the broad conceptions and without exploring in more detail other causes and effects, I should like to be so bold as to add a few of my personal thoughts on the responsibility that the three major sections of our economy, industry, labor, and Government, should take toward automation.

All three of these sections of our society must undertake to support and encourage the orderly growth of more and ever more automation. They must constantly publicize and educate all of society of the good that its greater productivity will create.

Industry through enlightened management and ownership needs to recognize that the increased production—that is, the increase in the wealth produced—must be divided between labor and owners in a fair manner. The division of this increase cannot be only between higher wages and more dividends. Some of the increase must be used to support the retired and displaced worker. More and more of it must be plowed back into capital. If automation's trend is to continue, industry must constantly have faith in the future and spend more for development, expansion, and plant improvement.

Labor must not be shortsighted and demand so large a share of the added wealth that it will stifle the ability of industry to place more capital per worker at labor's disposal.

Government at the local, State, and National levels must not neglect their obligation to enforce a fair division of our created wealth and must not spend their share ineffectively or wastefully.

If there was ever a proper place for the encouragement of automation, it is in government, for its benefits there can only result in the good of the society as a whole.

Industry, through education within its own units and divisions, can improve the humanitarian relation toward its workers, can seek to encourage better means of lightening the burden of the displaced worker, and can through education and training assist in the upgrading of its labor. It is, of course, true that many units of industry are making great progress along these lines, but many others are not. As you all know, labor relations' policies of today are a vast improvement over those of only a few years back. Both labor and Government should recognize and differentiate between those units of industry which are progressive and those that are not and encourage the progressive units.

Labor, and particularly those divisions that are organized, have in many instances of late years better recognized their share of responsibility, but much improvement can be asked for yet. It is not enough any longer for the unions to demand for their members only higher wages and more fringe benefits, but they must seek to find better means to tax their membership for the aid of the technologically displaced members. This may sound like heresy to some labor leaders but it has been a long established and accomplished fact by others, much more progress can be achieved, however, in this field.

There should grow within labor a better knowledge of the "harm to all" that the encouragement of featherbedding does, for if automation is good for all, then inversely featherbedding is bad for all.

Nor will the guaranteed annual wage, in my opinion, prove to be the blessing that some of its authors think it will be, and large sections of labor can never fall under its protective wing.

Labor must also recognize and educate its members that it is the duty of all workers to deliver an honest day's work and that a dole of any kind from any source is a harmful thing, a temporary measure to assist in cases of hardship; that it must not be abused and that every effort humanly possible should be exerted to get off and back to gainful employment.

Government also on all levels can be mindful of these factors and should not establish allowances for unemployment either so low as to be of no help or so high as to encourage idleness. Much better control over this aspect of the problem can be done at local and State levels than is now being done.

Labor by better cooperation with industry can accomplish much more than is now being done to improve the education and upgrading of its members. If by no other means than through a publicity campaign on its part, they can explain the good of automation and encourage their members to prepare themselves for better and more responsible jobs.

Government responsibility being for the good of all must keep the confidence of the governed high—must be mindful of the good of the whole even at the expense of the few. This does not mean that Government has to accomplish everything by legislation, particularly at the national level. Much can be accomplished better by the orderly assembling and evaluation of facts—just as this committee is constantly doing—then armed with the facts give proper emphasis and publicity to the conclusions. Many correcting measures can then be taken at local and State levels with better and more equitable results. Such results can assist in shortening the suffering in distressed areas.

A recognition on the part of all sections of our society from the individual to the Congress of the people must realize that our society must be kept dynamic and its produced wealth per capita kept ever increasing.

In conclusion, automation must be encouraged, means must be found to force its growth, by more liberal tax and depreciation policies, by better aid to our small and growing progressive concerns, and by assistance to the displaced worker without destruction of his will or need to work.

The CHAIRMAN. Senator Flanders, since this gentleman represents the very type business that you spent your life in, I think you are the proper one to interrogate him, so I shall now yield to you for myself and also for the staff. Take such time as you desire.

Senator FLANDERS. Mr. Chairman, I don't want to take the exclusive responsibility of interrogating, but I do appreciate the opportunity.

I would like, first, to inquire, Mr. Barton, whether you have taken into consideration the effect this "Zipper" can is going to have on the can-opener industry?

Mr. BARTON. Yes, sir; I thought about it. If we can ever make it work it is going to be very hard on the can-opening industry.

Senator FLANDERS. I kind of like that type of opener which is stuck on the kitchen wall. The first one of those I ever saw was made in Vermont, by the way. I don't see but what that can-opener industry has got to look out if you get this type can going.

Now, in your testimony you say "Many of us have incorrectly defined or spoken of automation as the second industrial revolution."

In my conversation with Mr. Carey I indicated my belief that the shift to continuous production, commonly called mass production, was a revolution of sorts. That raises the question as to whether this automation is anything more than that. I take it, that your point of view is that automation is a process that is going on all the time?

Mr. BARTON. Yes, sir; and is a part of a process that has been going on all the time.

Senator FLANDERS. It has been going on all the time and I take it that, in your judgment, it is not of a cataclysmic sort; it is just one of the things that happens, and is going on. I say of a cataclysmic sort; I mean of a sort which requires emergency measures to meet it.

Mr. BARTON. I don't believe it is required.

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Senator FLANDERS. In your paragraph on industry, you do indicate, however, that it is in the nature of a continuing adjustment. You speak of increased product which must be divided between labor and owners in a fair measure, some for the retired and displaced workers, more plowed back into capital, et cetera. Steps do have to be taken to meet such problems, but they are general measures, I take it, which you feel apply to all improvement in production?

Mr. BARTON. Perhaps I have given you slightly the wrong interpretation of my thinking there. It seems to me that in the past we have only had one thing to divide, and that was a greater productivity that man has been able to produce. That has been divided between more capital and higher wages, and shorter hours, and I indicate here, or I wish to indicate here, that I think that trend will continue, and is healthy.

It is a question of the evenness or equitableness with which it is divided and, of course, in any individual case it may not be properly divided, but as society as a whole finds a level for its division.

Senator FLANDERS. I wanted to question your reference to "technocracy." To me that means a movement which got underway during the years of the depression, which proposed to turn our whole economic system over to engineers and had a faintly or less faintly Fascist connotation. So far as I am concerned, I hate to see that word revived which, to my mind, represented a movement which fortunately has disappeared. I hate to see it used here in any favorable sense.

The CHAIRMAN. May I impose upon you, Senator Flanders, to act as chairman until you finish here and then adjourn the committee until 2 o'clock? Mr. Barton is the last witness this morning. I have another engagement.

Senator FLANDERS (presiding). Yes, sir. Now, Mr. Barton.

Mr. BARTON. Well, perhaps I don't like the word "automation" any better than I like the word "technocracy." Technological improvement—however, I accept your criticism in that respect.

Senator FLANDERS. After all, that is a comparatively small matter in this discussion.

Mr. BARTON. I don't think it is pertinent in the broad sense.

Senator FLANDERS. The point I do get from your discussion, I have already mentioned. You feel that what is called automation is a part of a continuing process that has been going on for a long time, and will go on, we hope, for a long time to come. I presume you feel that this long, continued process does at times introduce a heavier burden of problems and at other times is easily absorbed.

Mr. BARTON. If you are speaking of the economy as a whole, I believe so, but if you are speaking of an individual within a plant, or a section of a plant, then there may be dislocations.

Senator FLANDERS Mr. Carey spoke of the advisability of meeting these individual cases in the plant so far as possible, or by society, retraining. It does come as a crisis for an individual. Now, would you say, in the first place, that developments such as you have described, which have been undertaken by your own company, have in general effected unfavorably mostly the unskilled worker or the skilled worker?

Mr. BARTON. Well, sir, I believe that, as a whole, certainly within the last 50 to 100 years, all of the technological progress has produced a requirement of higher skills on the part of the labor force. Today it is getting so that it is increasingly difficult to get people that wish to do menial manual labor. We are upgrading by our educational system, and the fact that we are keeping more and more of our youth in schools, we are preparing them. Not that it is perfect preparation, by any means, but the trend is there.

Senator FLANDERS. Are you saying that it is hard to get the unskilled man, but that there is less need for him?

Mr. BARTON. I trust there is. I know there is less and I think there should be even less.

Senator FLANDERS. Have these remarkable and extensive automation developments resulted in a higher or a lower percentage requirement for unskilled labor?

Mr. BARTON. Maybe I can give an example that will answer that specifically in the bluebook. I beg your pardon. It is the last one, the electrical controls. In the electrical control section, the next to last page, on the left-hand part of the page on that spread are two photographs of a dragline control. That automatic control was employed in one of the largest, if not the largest, dragline in the country, in Florida.

It completely and automatically controls all operations on a great big dragline.

Senator FLANDERS. What is the nature of the industry?

Mr. BARTON. It is a mining industry in Florida, mining—it is International Minerals. This received a considerable amount of publicity in the technical journals, and it replaced not so many workers, but it is an air-conditioned cabinet, and the operation is now performed by a graduate engineer that they put inside of this, and, true, he does the work of 4 or 5 draglines, but certainly in that particular case it upgraded the individual operator.

Senator FLANDERS. Would you make that as a generalization, namely, that, in general, the highly develop automatic processes raise the percentage of skill required?

Mr. BARTON. Very positively, particularly in so much as we put in these machines, as they are increasing in number in the plants, we must have more and more higher skilled individuals to maintain them and keep them in operation.

Senator FLANDERS. Years ago—I forget just when—I visited one of the early developments of this sort. The name of the company has escaped me. It was in Milwaukee, and they were making automobile chassis frames. I don't know whether you can name that.

Mr. BARTON. Yes. That was the A. O. Smith Co.

Senator FLANDERS. That was it. I looked into the room where this thing was going on, from raw material to a finished automobile chassis frame, and I didn't see much of any men. There were 2 or 3 men around watching the product, and then I made further inquiry and went to an adjacent building, where there were quite a lot of highly skilled mechanics making and repairing the tools, making repairs on parts of the machinery which had been replaced by standby parts, and so on, and it struck me at that time—how many years ago was it?

Mr. BARTON. It must be 25.

Senator FLANDERS. Is it still running?

Mr. BARTON. I believe so; yes, sir.

Senator **Flanders**. It struck me very strongly that as compared with the conventional processes of making the chassis frame, that the degree of skill required to keep this thing going was very much higher than the grade of skill required to make chassis frames for the old process.

Mr. **Barton**. That is exactly what I tried to say before.

Senator **Flanders**. Of course, that is contrary to what you might call the popular point of view, which is that developments of this sort make the workers into just low-grade machine tenders of some sort. You feel that it does definitely upgrade the percentage of skill required?

Mr. **Barton**. May I put it a different way? The more the trend is applied, the less the need for the unskilled, and the greater the need for the skilled, and therefore the greater the incentive, whether or not it is being answered correctly, by industry, Government, or the unions; the need is increasing for greater and greater skill, and therefore the urge on the individual to prepare himself is present, whether or not he does it correctly or not is another question.

Senator **Flanders**. I have no further questions.

Do any of the staff have any suggestions?

Mr. **Ensley**. No, unless Mr. Barton would like to comment on implications of what he has just now said for our educational program.

Mr. **Barton**. Well, there are many broad economic problems that will always be with us, as to whether or not we as a society are properly preparing our individuals who make up that society in the proper manner, whether or not we are properly dividing the wealth of the country to give us a broader base of purchasing power, and 1 thing, and one thing only seems to be outstanding in that regard, in my opinion, and that is it seems to me that our Governments' problem is a problem of keeping our society dynamic and having faith in themselves, because our Government is our society and we must keep our people with faith in the fact that we are going the right way.

In my opinion, the trend is right. It should be encouraged.

Mr. **Ensley**. My question dealt more particularly with our educational system. Are we turning out enough trained scientists, mathematicians, and so forth, to conceive, develop, and man the new technology?

Mr. **Barton**. I don't believe we are. I believe that it would be good if we could find ways to encourage the scientific schools to expand and train more students for the future. They will be needed more and more in the future.

I haven't got a specific answer of how.

Mr. **Ensley**. The implications of automation also are for shorter hours of work and more leisure time.

Mr. **Barton**. And that means more intelligence, if you are going to use it properly.

Mr. **Ensley**. That is the only question I have.

(The material referred to by Mr. Barton dealing with the Rockford Ordnance plant is as follows:)

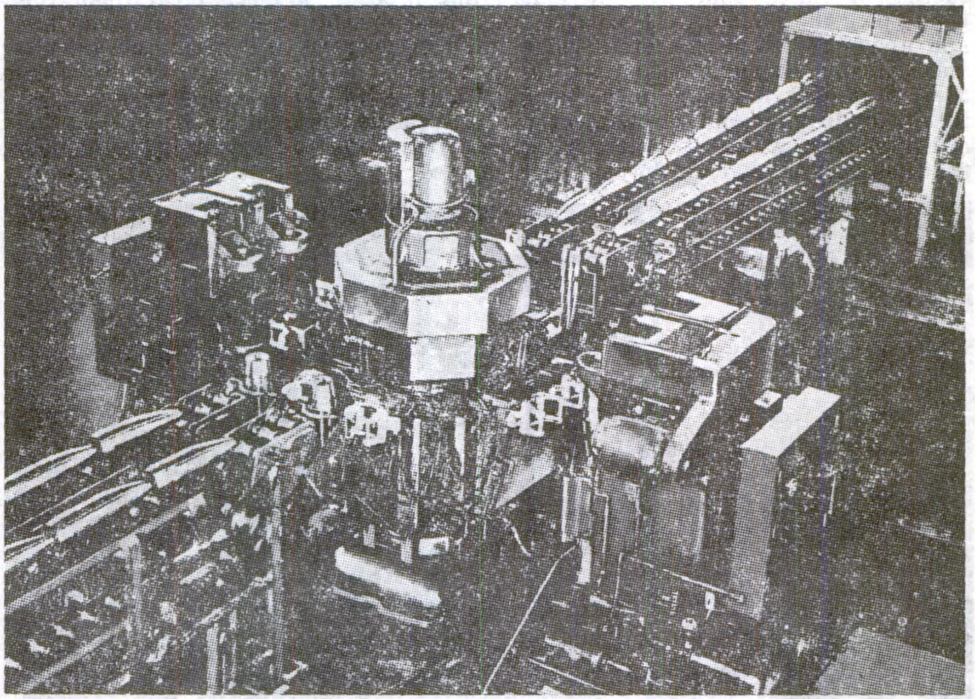
[Reprinted from Machinery, February 1946]

THE AUTOMATIC MANUFACTURING PLANT—MASS PRODUCTION SHOP OF THE FUTURE

A plant designed and built by the W. F. & John Barnes Co. during the latter part of the war for the manufacture of high-explosive shells suggests possibilities for mass-production plants for peacetime manufacturing that will practically constitute a single automatic unit

(By Erik Oberg, editor, Machinery)

Many of the wartime developments will have a profound effect on the manufacturing practices employed in making peacetime products. Bold and ingenious ideas that would hardly have received a hearing in peacetime days won acceptance in the wartime emergency because of the urgent demand for more and ever more war materiel. A wartime idea that successfully materialized was the 155-millimeter high-explosive shell plant that was designed and built by the W. F. & John Barnes Co. during the latter months of the war and was just ready to be placed in operation when the fighting ended. This plant may well be termed an automatic mass-production factory. Here heavy parts, weighing in excess of 125 pounds, are handled mechanically from the time the billets enter the heating furnaces until the completed shell, after having passed through all machining, heat-treating, and other operations, is ready for inspection.



A group of two threading machines with a robot mechanism in the center for automatically loading and unloading them.

This plant was conceived and built by the executives, engineers, and production men of both the machine tool and ordnance divisions of the Barnes organization. Without the complete cooperation of these groups, the results accomplished could not have been achieved. The Barnes organization not only engineered the plant, but engineered and built the bulk of the special machinery, and worked with the engineers of other concerns that supplied special equipment, offering them engineering ideas as to what would be required, and then working out the details with the supplying companies' engineers.

The present article will briefly describe the essential equipment in this automatic shell-manufacturing plant, not with the idea of presenting a treatise on shell manufacture, but rather of showing the possibilities of this type of manufacturing plant as applied to peacetime mass production.

It should be noted that in the design of the facilities of such an automatic plant, all ideas much begin to take form with the building itself. A system of intercommunicating trenches and tunnels is incorporated to carry all of the various services and to provide for the automatic handling of chips. Even the foundations are designed with a view to the ultimate purpose of the plant, and are tied in with the main tunnels to provide easy access for maintenance of the services and for proper plant housekeeping. Special attention is given to the exhausting of fumes and gases and to the maintenance of suitable shop temperatures. As an example of the latter considerations, it might be mentioned that in the forge shop a full-length roof ventilator is coupled with louver control of windows at the floor level, in order to reduce the temperature in this area and to provide the best possible working conditions.

In the design of the shell plant referred to, it was kept in mind that practically all manufacturing operations would be performed by women, and hence, to facilitate the operations, the controls were largely through pushbuttons.

To avoid the manual handling of the shells, two fundamental types of equipment were provided—first, a complete conveyor system for transferring the heavy projectiles from operation to operation; and, second, a machine, on the success of which hung the entire handling process—a mechanical robot that would pick the shell (or other part) from the conveyor, load it into the machine, and upon the completion of the machining cycle, remove it from the machine and transfer the machined part to an outgoing conveyor. By synchronizing the motions of this mechanical robot with those of the machine through electronic, hydraulic, and mechanical controls, it is possible for one operator—either man or woman—to obtain a production from the machining equipment that has been unheard of in past performance.

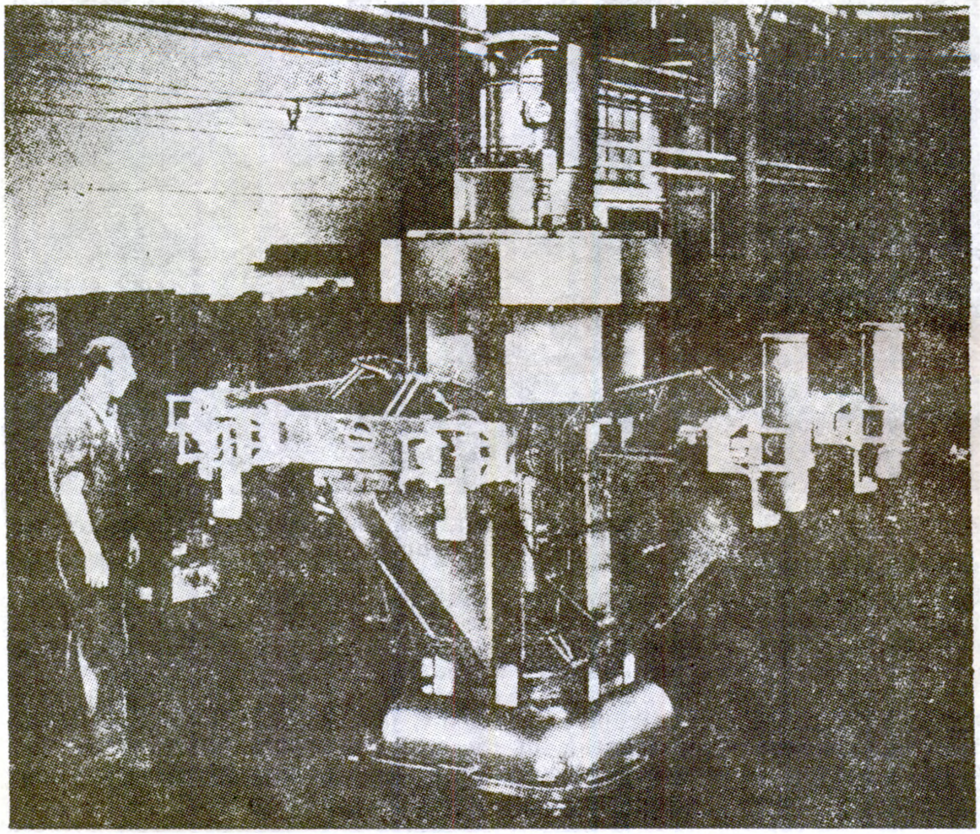


Figure 1.—Typical robot mechanism used to automatically load and unload the equipment that performs machining operations on the shells.

Since the success of an automatic plant such as described hinges upon the possibility of handling heavy forgings or machined parts without the touch of a human hand and of loading and unloading the machines automatically, the robot mechanism will be referred to first. Figure 1 shows a typical mechanism of this kind used for automatically loading and unloading shells in the operation of a four-station center-column machine.

This robot mechanism consists of a base on which is mounted a rotary four-sided center column. On each of the four sides of the column is mounted a vertical slide which serves to bring the shell or other part into and out of the holding fixtures in the machine. On the top of each of these slides, horizontal ways have been machined which carry the mechanical hands that transport the shell to and from the conveyors and in and out of the machines. Briefly, the operation of this mechanism is as follows:

The mechanical hands advance toward the incoming conveyor, and each hand clamps a shell. Then the mechanism and slides move back toward the center column of the machine, withdrawing the shell from the conveyor. The robot machine is now indexed, and the hand slides advance into the machine that is to perform an operation—in this case a rough-turning machine. The vertical slide next moves upward so that the open end of the shell, properly faced square in a previous operation (in this case in a centering and cutting-off machine), moves over an internal mandrel against the spindle shoulder. The tailstock then moves into the machined center in the base of the shell, after which the mechanical hands are released. With that release, hydraulic pressure expands the jaws of the internal mandrel, clamping the shell for the turning operation. The vertical slide now moves downward, the hand slide moves toward the column of the loading machine, and the process is reversed for another loading operation.

When the shells have been rough-turned, the robot reverses its loading procedure by moving in empty, picking up the finished shell, indexing to the proper position, and releasing the rough-turned shell to the outgoing conveyor. The operation of removing the shell from the conveyor and loading the machine, or the unloading of the machine and depositing of the shell on the outgoing conveyor, requires 30 seconds.

It will be noted that 1 robot serves 2 machines and that 1 woman operator controls the 3 pieces of equipment. It is estimated that the production from this unit of 3 machines is approximately 10 times the production of the same personnel using standardized shell-turning lathes.

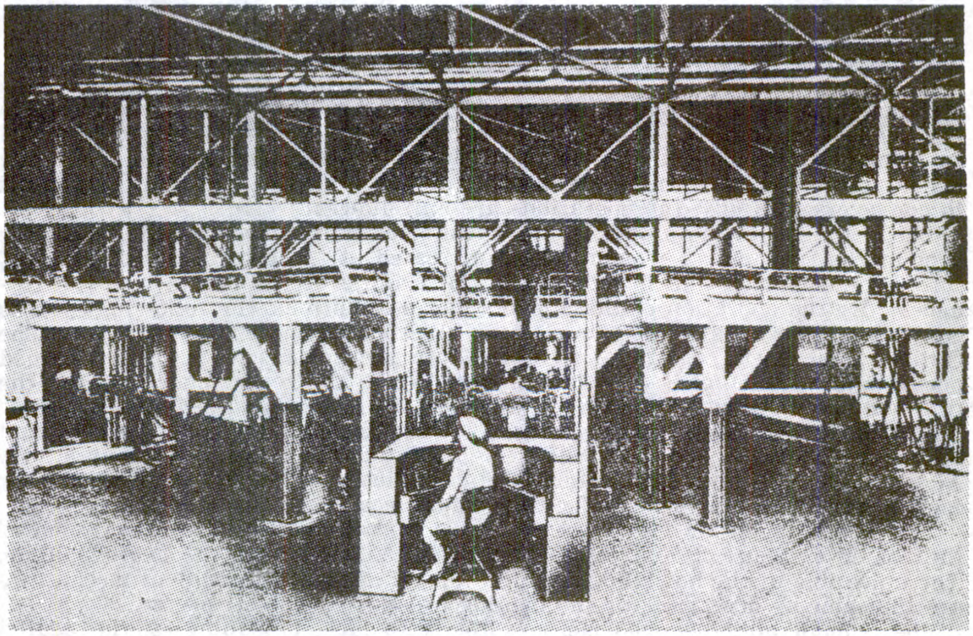


FIGURE 2.—View of the furnace room of the forge shop showing two 28-foot Salem rotary furnaces which are automatically loaded with billets and unloaded by 2 women operators employing pushbutton and lever control.

Another point that was considered in the entire engineering of the plant was the control of the movement of the shell so that it was never necessary to dump coolant out of the inside of the shell. In some automatic arrangements for shell turning, there are specific operating stations arranged merely to turn the shell upside down, so as to throw out the coolant. This is not necessary if the shell is moved through its various operations with the nose downward.

While a robot mechanism of the type suitable for the work to be handled is perhaps the basic conception in an automatic manufacturing plant such as described, there are many other unique features in the production line that aid in making all the operations completely automatic. These features, as employed in the manufacture of shells, will be briefly reviewed in the following two paragraphs, but it should be noted that with slight variations they can be applied to a great variety of mass-production parts.

In the shell-manufacturing plant here described, there is an automatic pallet mechanism for loading the heat-treating furnaces; there is a complete control of the hot nosing operation, by which perfect alinement and temperature control can be maintained; there is a system of production-line gages for checking all important items as the shell moves down the production line; there is a unique method for banding that insures an absolutely gastight fit of the band on the shell; an dthere are automatic features applied to the control of gages, tools, cutting compounds, and all other elements entering into the manufacturing process.

This control of gages and tools could be greatly elaborated upon, since it constitutes one of the important features in the success of this type of automatic manufacturing plant. The shell, for instance, as it progresses down the conveyor line, is automatically lifted into an electronic gaging device. The gaging is performed, and in some cases recorded on a chart, after which the shell is automatically placed back on the conveyor.

In the case where the manufacturing processes begin with forgings, the success of an automatic production line depends materially on the weight, accuracy, and treatment of the forgings. Even the forging operations can be so engineered that the manual handling of billets and forgings is eliminated and pushbutton controls are provided for the main processes, including the operation of the rotary furnaces, forging presses, and similar equipment. As a result, in the shell plant described, the operation is so thoroughly automatic that all handling of the material at the heating furnaces is controlled by a girl at a pushbutton station.

DETAILS OF OPERATION OF THE HEATING FURNACES IN THE FORGE SHOP

Figure 2 shows two 28-foot Salem rotary furnaces used for heating billets in preparation for forging. In the center may be seen two women operators seated in front of control boards, by means of which the furnaces are automatically loaded with billets and the heated billets automatically removed and transferred to conveyors. Briefly, the operations are as follows:

The billet, cut to the proper length, is automatically conveyed to the entrance door of the furnace. A woman operator, seated at the control board, handles, through pushbutton and lever control, the loading of the billets into the furnaces. By the operation of these levers and pushbuttons, the following cycle is controlled: The jaws of the ram clamp a billet at the end of the conveyor. The furnace door opens; the ram advances into the furnace to a predetermined position, and the billet is deposited on the floor of the rotary hearth. Next the ram withdraws from the furnace and the operation is repeated until four billets have been placed in the furnace. The furnace door is then closed and the rotary hearth is indexed, ready for loading another groups of four billets. All of these operations are performed automatically, with one woman operator controlling the loading of both the rotary furnaces.

The woman operater shown seated at the control booth in the background of the center of figure 2 controls the automatic unloading of the heated billets. The unloading of the hot billets and the control of the ram and door mechanism are the same as described for the loading process, except in reverse.

The woman operater who controls the automatic unloading of the heated billets also controls the indexing of the hearth. Obviously, it is important that the billets be unloaded when they have reached the proper forging temperature; hence the removal of the billets from the furnace and the indexing of the hearth are tied together.

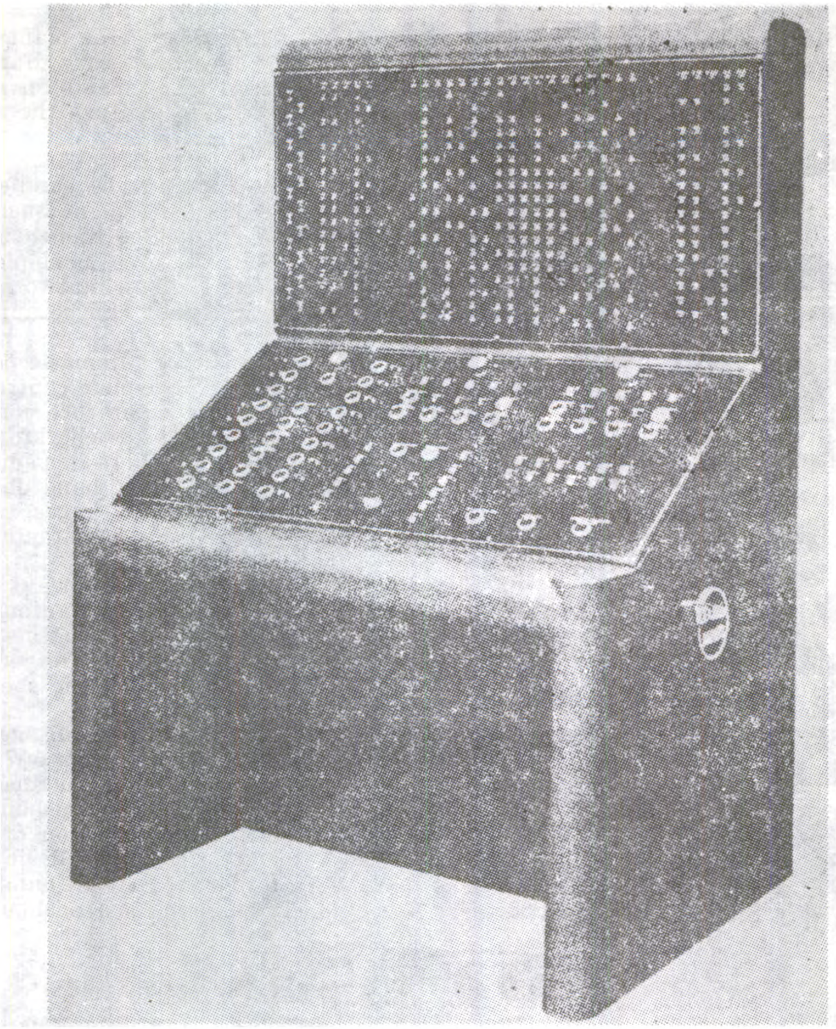


FIGURE 3.—Electric control board for the operation of a group of 2 machining units and 1 loading unit.

The hot billets are unloaded onto a conveyor which delivers them to a water-scaling operation under 2,000 pounds of water pressure. The descaled billet is a preliminary sizing press prior to piercing, all of these operations being automatic like the rest of the installation.

ELECTRIC CONTROL BOARD FOR OPERATING CENTER-COLUMN MACHINES

One of the most interesting features of this entire automatic manufacturing plant is the ingenuity displayed in providing automatic control of turning, boring, and threading machines. The control board (fig. 3) is taken care of by 1 woman operator, who controls the operations of 2 4-station center-column turning machines. Two machines of this type are placed facing each other, with an automatic loader between the 2 machines, similar to the arangement shown in the heading illustration. The machines are designated left-hand and right-hand machines, according to their relation to the automatic loader. A left-hand and a right-hand machine and an automatic loading machine are referred to as a group. A control panel, such as shown in figure 3, is provided for interlocking and controlling each group of machines. A system of lamps and push-buttons is assembled in this control desk, with indicators showing the operating conditions of the group of machines, and providing means for controlling their operation.

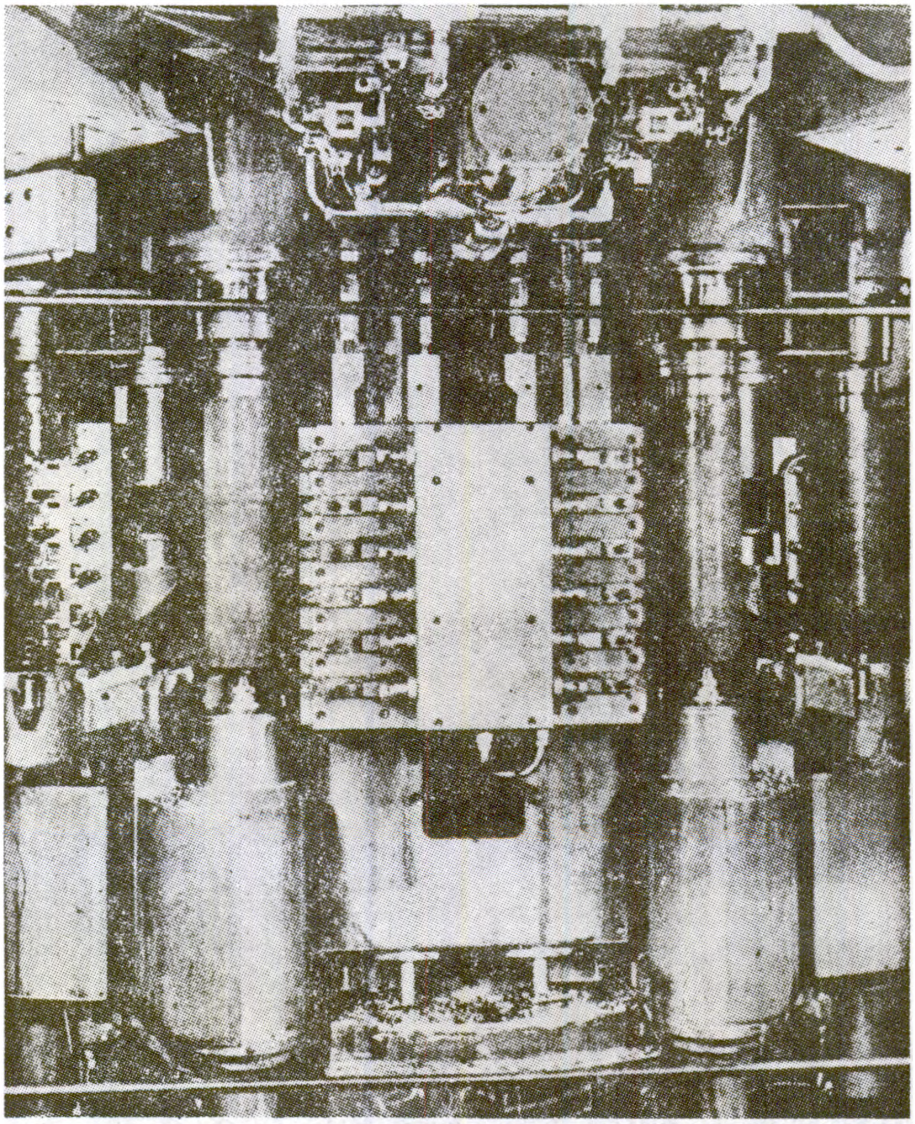


FIGURE 4.—Close-up view of tooling of a Barnes four-station center-column machine used for rough turning the forgings.

The lamps on the control desk are wired so that they will burn at a low voltage when not picked up by the circuit controls. In that way, the operator will know that a lamp that is not lighted is burned out. A selector switch is provided so that the operator can turn off all lamps showing the control circuit condition when they are not in use.

The upper panel on the control desk contains a system of lamps that will show the operator the condition of the control circuit if the machine stops during the automatic cycle or fails to perform one of its operating steps during a hand-operated cycle. This indication will localize any trouble in the machine controls, thus making it easier for any control failures to be located and corrected. The lamps in the upper control desk panel are arranged in horizontal rows and vertical groups. The top row of lamps indicates the condition of the control circuit at any place in the cycle or when the machine stops.

The remaining rows of lamps on the upper panel indicate the condition in which the control circuit should be at the end of the step being performed by the machine. The left-hand group of lamps indicates the operating step that the machine is in when it stops. Thus, a comparison of the lamps in the upper row with the lamps in the row indicated by the step lamp that is lit in the left-hand group will show which section of the control circuit has failed to operate. This section can then be checked to determine the trouble. Similarly, the vertical groups of lamps are arranged to indicate steps in the operating cycle in each of the two machines being operated.

The lamps and pushbuttons in the lower panel of the control desk are arranged in groups according to their relation to the control circuit. Every possible contingency in the operation of the machines is taken care of, enabling the operator to see at a glance how the steps in the operation of the machines are progressing, and to operate the various controls as required.

Separate pushbutton control boxes are provided for each machine and for the automatic loading machine for operation during a jog cycle. The jog cycle is used for testing and setting up the machines only.

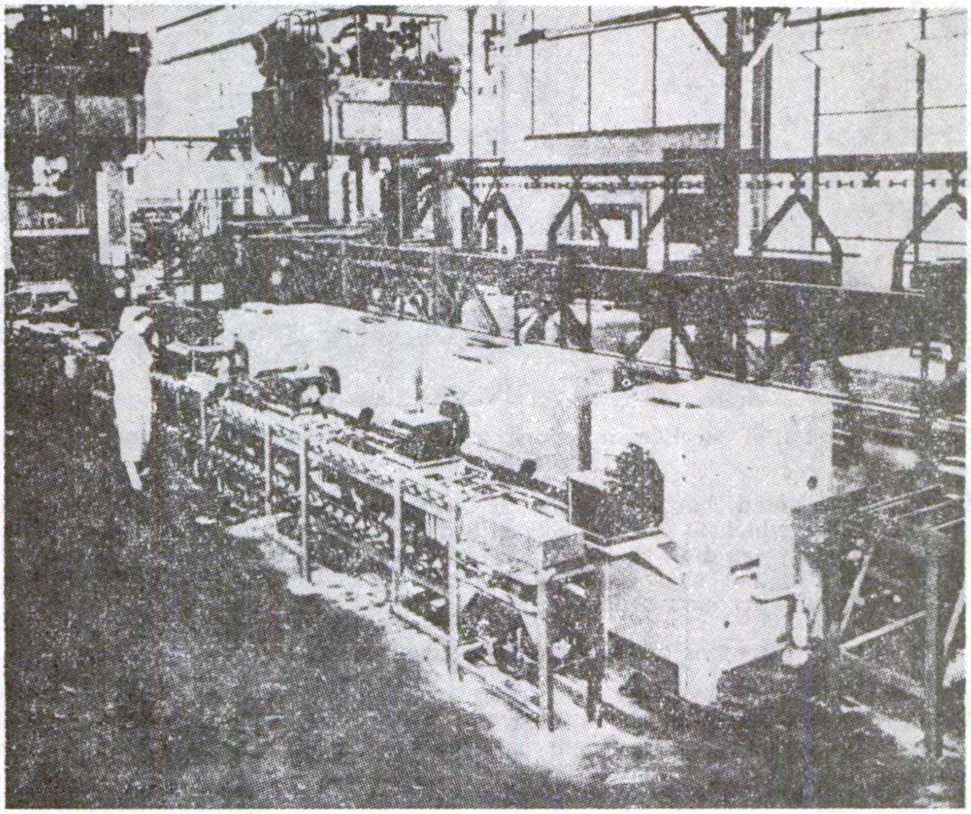


FIGURE 5.—Battery of Tocco high-frequency induction heating units located in their proper place in the automatic production plant.

Figure 4 shows a closeup view of the tooling of 1 of the 2 Barnes 4-station center-column machines used for rough-turning the shell forgings. The machine consists of a main supporting base carrying a rotary table. This rotary table is mounted on a four-sided vertical column which carries the toolslides. On top of the column is mounted the main actuating mechanism, including the individual hydraulic controls and the electrical panels for each station. In principle, the machine consists of eight lathes mounted vertically around a center column.

After two forgings have been positioned and clamped as described in connection with the description of the robot mechanism loading machine, figure 1, the center column indexes, bringing 2 more spindles to the loading position; and after these 2 spindles have been loaded, the machine again indexes until each of the 8 spindles is loaded, 2 spindles being loaded at once. Then the toolslide is indexed and starts its machining cycle. This toolslide carries two banks of tools, one for each spindle assembly. The 6 tools are fed hydraulically into the shell to the proper depth, after which the entire slide feeds upward approximately 4 inches, completing the rough-turning operation. The seventh tool shown at the base and to the left of the chucked shell then takes a sweeping cut across the base of the shell, leaving only a small center for succeeding operations.

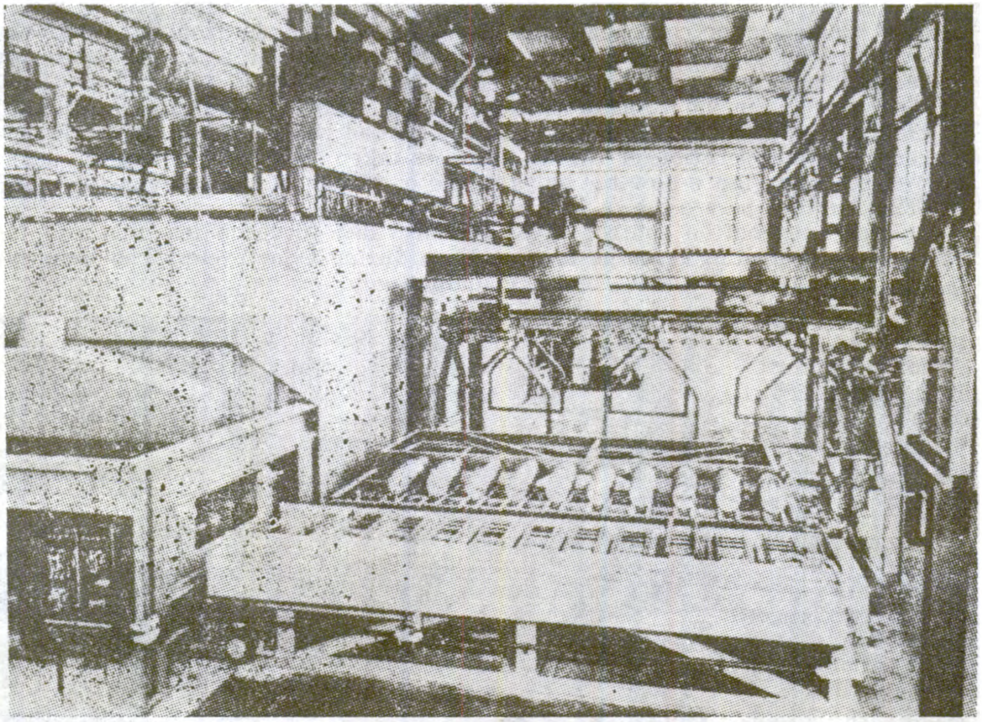


FIGURE 6.—Pallet mechanism which automatically loads shells into a heat-treating furnace.

It will be noted that the machinery has been so designed that all tools are set in blocks which fit into predetermined positions on the machines, so that, when the tools are dull, the tool block itself is removed, sent to the toolroom, and the cutting tools sharpened and set to the predetermined position before it is returned to the production floor.

AN EXAMPLE OF AUTOMATIC HIGH-FREQUENCY INDUCTION HEATING

Figure 5 shows a battery of Tocco high-frequentcy induction heating units used to heat the nose of shells in preparation for the nosing operation. Obviously, this equipment with slight modifications could be applied to numerous other parts in mass-production industries.

After the rough-turned shell has been placed by the robot on the outgoing conveyor, it is conveyed to the Tocco induction nose-heating units. There are four of these units in each production line. The 4 units serve the 1 vertical hot-nosing press shown in the background. The rough-turned shells are kicked off at the machining stations, move down a conveyor onto a small slide which, in turn, loads them into the boxlike fixtures in which are mounted the heating coils. The nose is then heated a predetermined amount, so that in the hot-nosing operation the following conditions will be met: The exact contour, both internal and external, will be maintained; the exact amount of metal required for the nosing operation will be available; the proper volume of the cavity will be maintained; and there will be sufficient metal for the final facing operation to give the correct finished length. When the proper degree of temperature is reached, the shell is retracted from the coils and again kicked onto the conveyor on which it travels to the nosing operation.

After complete inspection of inside and outside contours, volume, and length, the nosed shells are conveyed automatically to the pallet-loading mechanism shown in figure 6. When 10 shells have been assembled, as shown in this illustration, the pallet is automatically carried onto the transfer table which, in turn, automatically conveys it into the heat-treating furnace.

GROUP CONSISTING OF TWO THREADING MACHINES AND A LOADING MACHINE

As previously mentioned, the groups of machines that perform machining operations consist of two machines with a robot-mechanism loading machine between them. The heading illustration shows this arrangement. Here two threading machines are placed one on each side of the loading machine. The robot mechanism of the loading machine picks two shells from the incoming conveyor, automatically indexes to the threading machine, and loads the shells in the clamping fixtures attached to the machine. Collapsible taps then thread the nose and retract. Next the shells are unclamped automatically and removed by the robot mechanism, which then automatically indexes and places the threaded shells on the outgoing conveyor. This conveyor then transfers the threaded shells to the next work station for the performance of other operations.

ANOTHER EXAMPLE OF AUTOMATIC MACHINING

Figure 7 shows a six-station machine used for turning and forming the rotating bands. Note that here, again, the shells are removed from the incoming conveyor by the robot mechanism and loaded into the machine. After being placed in position by the robot mechanism, the shells are pushed into collet-type chucks, and having reached the proper point of location, are clamped. These chucks are so designed that every shell will be accurately located. There is no downward or upward movement of the shell throughout the clamping operation. The head of the turning machine is then indexed to each of five machining stations where the rotating band is successively rough turned, rough formed, and finish formed.

The foregoing brief outline of a few of the operations performed in the Barnes automatic shell plant will doubtless prove sufficient to indicate that such automatic plants can be designed for the mass production of numerous parts and products for peacetime industries. Enormous quantities of parts can be produced by such an arrangement with a minimum of physical effort and labor.

As mentioned at the beginning of this article, it was not the purpose to present a complete description of the manufacture of shells, but rather to emphasize the possibilities of this type of manufacturing layout as applied to peacetime production. This plant, in its original conception and in its final detailed engineering, is believed to present a basic idea for the mass-production plant of the future.

This development has not only an industrial significance, but a social significance as well, because as man contrives to produce the things that he wants for

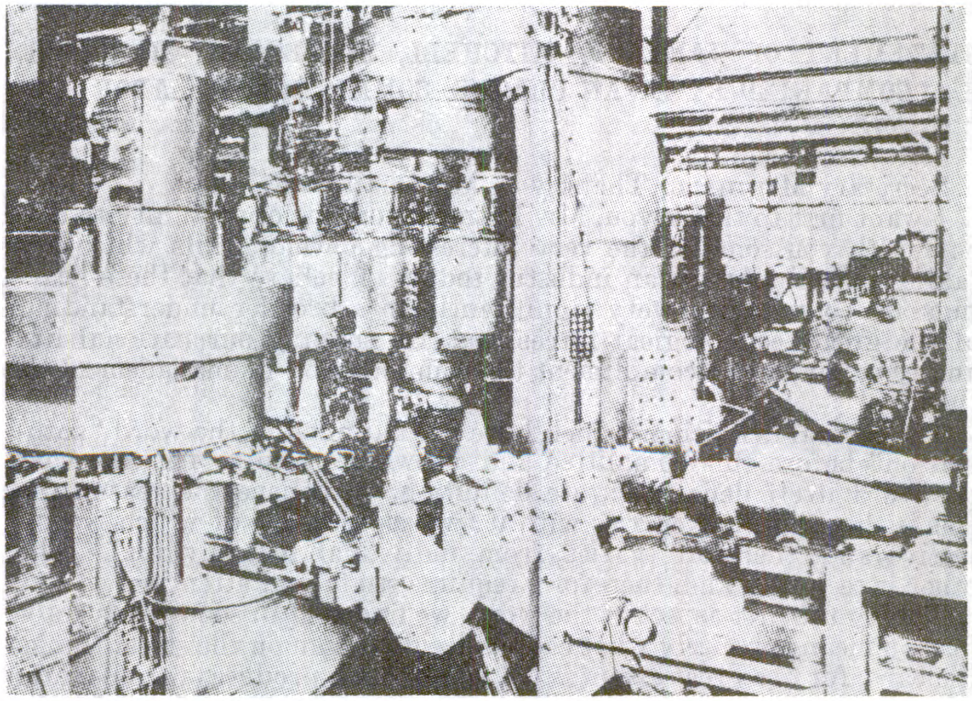


FIGURE 7.—A six-station machine for turning and forming rotating bands. The shells are automatically delivered by conveyor and robot mechanism, and are then automatically clamped and machined.

his comfort and well-being with the least amount of expense and effort, the higher will be the living standards that he can enjoy. The automatic plant of the future is simply another link in the chain that provides more goods for more people at less cost and effort.

Senator FLANDERS. This hearing is recessed. It will meet again in this place at 2 o'clock, with Secretary of Labor Mitchell as the witness.

(Whereupon, at 12: 13 p. m., the subcommittee recessed to reconvene at 2 p. m., same day.)

AFTERNOON SESSION

The CHAIRMAN. The subcommittee will come to order.

We have with us this afternoon the Secretary of Labor, Mr. James P. Mitchell.

When we first undertook this inquiry into automation, we naturally looked to the Department of Labor as a source of information on what this whole movement means to employment levels and individual workers. As I understand it, your Productivity Division is engaged in a series of studies trying to analyze the changes in the numbers and character of employees in places where automatic procedures have been or are being introduced. You, I understand, will present these and some of the summary views to us this afternoon.

We are also interested in your personal thinking as to the handling of the personnel problems involved.

Since your Department is also making studies of productivity, we should like to have you add whatever you can to our understanding of the commonly used concepts and statistics on productivity.

Mr. Mitchell, we are delighted to have you. You may proceed in your own way if you desire.

STATEMENT OF JAMES P. MITCHELL, SECRETARY OF LABOR, ACCOMPANIED BY EWAN CLAGUE, COMMISSIONER, LABOR STATISTICS

Secretary MITCHELL. Thank you, Mr. Chairman.

I want first to thank you, Mr. Patman, for this opportunity to discuss with you some of the very interesting developments which are taking place in American industry today. I believe that these hearings are contributing very significantly to a broader understanding of the great technological forces that are shaping our national life and economy, and I compliment the committee on its management of them.

The several definitions which have been applied to the word "automation" before this committee and elsewhere seem to indicate that the word itself defies accurate definition. I believe the reason for this is that the word carries with it two aspects, one of which is subjective and, therefore, varies from individual to individual. The other is technical and, therefore, requires study and attention.

Taking the first aspect of the word, we find that in some ways automation means precisely what each individual man on the street thinks it means, for to a great extent it is a word which produces various sorts of fears in various sorts of individuals—fear of change, fear of technology itself, fear of displacement, fear of unemployment, fear of

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machines, fear of science in general. In this sense, automation is nothing new, since these same fears have been with us in one form or another ever since the first caveman resented fire.

I am reminded, in fact, of the hearings held by the House Labor Committee less than 20 years ago. The discussion centered around a resolution that would have required the Secretary of Labor to draw up a list of laborsaving devices and a parallel estimate of the number of people probably unemployed as a result of their use.

So the present discussion is not within an unfamiliar context.

Taking the second aspect of the word, the technical one, we find that in a general way the word represents technological change, which surely is nothing new. It represents a movement certainly as old as the industrial revolution and probably older. Now, technological change varies, as we all know, in rate and degree. Its latest manifestation, coming as it has in a favorable setting of growth and prosperity, has appeared with relative swiftness and in some ways spectacularly.

It has come with such devices as complex automatic systems, electronic controls and regulators, feedback systems, transfer machines, conveyors, and the like. It has been attached to many self-regulating processes which have reduced the number of workers needed to perform a given job. When you get down to specifics there is some argument about the precise definition of this second aspect of the word. However, we can all agree that it is the latest development in the progress of industrial technology, the latest step in the long search for ways to replace human energy with mechanical energy.

APPLICATION

Our preliminary studies in the Department of Labor indicate that there is no reason to believe that this new phase of technology will result in overwhelming problems of readjustment.

I repeat, there is no reason to believe that this new phase of technology will result in overwhelming problems of readjustment.

For example, the Department recently completed a study of a large insurance company which has installed an electronic computer to process some of its records.

(The information appears at the end of Mr. Mitchell's testimony.)

Secretary MITCHELL. The company, like all companies that can best utilize the new technology, is an expanding one. Since it takes a long time to activate the complex new equipment, the company has been able to plan carefully the reassignment and retraining of the workers affected, so that no one will be laid off. The company has transferred some employees to other types of work and retrained others for work on the computer itself. To operate the high-speed electronic computer a number of people were selected from the staff for training and assignment as programers and analysts and operators. New jobs that never existed before electronics was introduced were created elsewhere in the company. Even after installation of the electronic data machines, the company faces a clerical labor shortage because of the ever-expanding volume of business. It is still going to employment offices for female clerical help for office work, as it did during the days of older technology.

We found a somewhat similar situation in a radio and televesion manufacturing company that had introduced printed circuitry and automatic assembling machinery.

(The information referred to appears at the end of Mr. Mitchell's testimony.)

Secretary MITCHELL. The company eliminated a number of hand-assembly jobs in which women worked, and set up a number of higher paid jobs for operating machinery. No one, however, was laid off on account of the change. All job readjustments were made without disturbance, according to the seniority and working rules of the union agreement. The company timed the installation for a period of seasonal expansion and company growth.

These two case studies are being submitted to the committee in detail. These examples, of course, are not necessarily representative of all industry or business. We are planning to prepare additional studies of other firms and industries.

So far our studies show that only large companies producing standardized goods for an expanding market have been able to use the more advanced types of industrial machinery. Operating in a context of high-business activity, with near-full employment, and indeed overtime in many industries, with widespread demand for products ranging from consumers' goods to new factory buildings, these companies have been able to keep to a minimum the dislocation which has sometimes accompanied technological change in the past.

Some fear that the diffusion of automatic production will be too fast. Others believe, however, that it will be introduced only gradually in view of its high cost and the long period of time needed for custom building and installation. History would indicate that broad technological changes are seldom abrupt, but rather that they take place in stages, affecting different industries at different times.

The effects: The effects of technological developments, including the one termed "automation," can be seen pretty clearly by looking at the historical record.

In the past technological improvement has meant: unskilled workers have decreased, semiskilled workers have moved up into skilled areas, and skilled workers have approached the status of technician. In 1910, for instance, unskilled workers represented 36 percent of the labor force. Five years ago they represented only 20 percent. Semiskilled workers from 1910 to 1950 rose from roughly 15 to 25 percent.

We can expect these trends to continue under the stimulus of improving technology.

Unskilled workers are leaving the farm, the building site, the mine and other activities. Our current high level of wages and employment indicate that they are successfully making the transition to higher skilled jobs and better pay classifications.

Improvements in industrial technology will reduce the number of boring, routine, and repetitious jobs. And, I believe we can expect that this will move all workers to a higher level of attainment and self-development. We can expect to see increased demand for workers with a high sense of responsibility and versatility, for mathematicians, engineers, and technicians of all sorts, for scientists and researchers. The worker of the future will require better basic education and better training than he gets now.

Our knowledge is not at present complete enough to determine whether or not there will be hardships to specific groups as a result of modern technological development. As I said at the outset, we don't foresee any overwhelming problems of readjustment. However, the application of new machinery to clerical, operative, and assembly type jobs may result in difficult transitional problems for women, many of whom are employed in these kinds of occupations. This is one of the areas which the Department of Labor is studying at present.

Perhaps the most sensitive indicator of the overall rate of adjustment which is forced on the economy by technological change is the index of industrial productivity. Studies for manufacturing, where newest industrial techniques are most utilized, indicate that the postwar trend of productivity has been somewhat irregular—perhaps a little higher than the previous long-run trend, but not higher than we have experienced in periods of comparable length in the past.

I propose later on to dwell on this at greater length.

Another effect of technological change can be seen in those areas of our country where we have pockets of unemployment. While this problem involves many other factors besides technological change, it is part of the whole picture, and certainly every effort should be made to prevent an increase in the number of workers stranded in such distressed areas.

This is a problem which must be met by management, labor, government, and perhaps most importantly, by each individual community. Like other problems arising out of technological advancement, it indicates the need in our country for the development of every worker to his fullest potential. As our scientists devise new methods and techniques in industry, so grows the opportunity for every worker to move to higher levels of attainment and individual fulfillment.

Preliminary studies made by the Department indicate that we have a shortage of skilled workers in this country today. As industry grows more complex, this shortage is bound to increase unless adequate training programs are set up. We must make sure that we do not waste our manpower, our most valuable resource, as we have wasted our other resources.

In this connection, we cannot afford discrimination in the utilization of the skills of any group. We cannot afford to waste the potention skills of 6 million Negroes. Neither can we afford to neglect the skills, aptitudes, and experience of mature workers over 45 years of age.

Every effort must be made to prepare the American worker for the changes which lie ahead. Certainly in this respect education and training are of primary importance. And when a worker is qualified, certainly every effort should be made to insure his fullest utilization regardless of his age, his race, his religion, or his place of national origin.

PROGRAM

There is no disposition within the Department of Labor to minimize the problems that might be created by accelerated technological development. At the same time we feel there are abundant grounds for optimism and confidence about the future.

Science and invention are constantly opening up new areas of industrial expansion. While older and declining industries may show reducing opportunity, new and vibrant industries are pushing out our horizons. This is the story of industrial America, and will continue to be.

We are learning, too, that consumer desires are expansible. The new products emerging from industrial research laboratories are creating the demand upon which entire industries may be erected.

The prospect of such expansion does not lessen our concern for the individual worker who might be displaced. The Department of Labor has a deep and abiding interest in our changing technology. While the technical aspects of such changes can be described in considerable detail, the human aspects are often difficult to delineate.

We are making, as I said, case studies of plants that utilize the new technology. This program is very small this year, but we hope to expand it.

We are also initiating a series of community readjustment studies, selecting towns where there has been a reduction in employment opportunities. We hope to determine the human, as well as technical, aspects involved in such areas and to investigate those practices that were most successful in meeting the community's problems.

We are giving close study to the development of the skills of the work force, through a pilot program authorized this year by Congress. In this field we are broadening our long-standing apprenticeship programs. The problem of the older worker who is particularly vulnerable to the effects of changing technology is the target for a study just begun.

I want to mention in connection with these tasks being undertaken by the Department of Labor the increasing activities in the States. At the local level, where technological change is first felt, it is very important to have an alert and effective system of employment offices, and a strong and well-administered program of unemployment compensation. These offices perform many important functions. First, they provide an alarm system by which to gage local displacement. Secondly, they provide an apparatus for the relocation of workers. The unemployment-compensation program furnishes income insurance for workers that cannot find work immediately. The States this year, I am glad to report, substantially increased the effectiveness of these programs.

CONCLUSION

I would like to leave you with this thought—in the past the developments of industrial technology have always brought with them a higher standard of living. There is no reason to suspect that this will not be so in the future. Indeed, I have every reason to believe that the workers of this country will continue to receive their fair share of the fruits of their work.

Management and labor have reached a degree of maturity and understanding unprecedented in our history, and I believe we can have confidence that they will continue to negotiate successfully their differences at the collective-bargaining table.

The industrial-relations problems of technological change are always critical ones. Our studies so far have shown that companies which have installed new automatic machinery with a minimum of industrial-relations problems have done so because they considered the problems of the individual worker in making the change. This personnel planning is as essential to modern industry as are the new machines, and I am sure that American management and labor realize this.

Government, too, has a responsibility to help provide the proper climate in which growth can take place, industrial and otherwise. I believe that we are conscious of this responsibility and that we will be able to maintain the present climate in which our country and its people have grown so much and in so many ways.

Last week, Mr. Chairman, you asked me in a letter to comment on the work which the Bureau of Labor Statistics has been conducting on the development of annual measures of output per man-hour in manufacturing industries, and to report on our findings in relation to developments in automation.

Mr. Clague, who is the Commissioner of the Bureau of Labor Statistics, is here at my side and both of us will attempt to answer any questions you may have after this short presentation in answer to your letter.

The development of the annual measurement of output per man-hour in manufacturing industries is a resumption of work which the Bureau used to do in the years prior to World War II. The series was interrupted by the war because no data were available to measure the vast shift from peacetime to war industry production, and then later the shift back. However, the reconversion to peacetime production had been completed by 1947, when the first postwar census of manufacturers was taken. There was a sample census in 1949, and there have been annual sample censuses since then. For the past several years the staff of the BLS have been working with these census data, and with other information at their disposal, in order to obtain a measure of the rate of change in output per man-hour in manufacturing; or, to state it the other way around, to measure the changes in the amount of labor required to produce a unit of output.

We now have some measures bridging the gap from 1939, the last peacetime year before the war, to 1947, when reconversion had been completed. We have annual indexes also for recent years through 1953.

Before we have a discussion of these figures, I want to stress the point that these data have limitations. Output per man-hour, or productivity, as it is often called, is not easy to measure and the data we now have available are not as good for making these measurements as we would like them to be. We should also bear in mind that productivity is a ratio which relates the output of the economy or some part of it to the amount of labor used in the production process. Such measurements reflect the influence of all the factors of production, the amount and skill of the labor required; the kinds of tools, equipment, and technology used; the raw materials processed; and the management skill in organizing the whole operation.

In order to minimize some of the limitations and to aid in interpretation the BLS has tackled the problem by preparing not 1 series of estimates, but 4 different ones. I shall not attempt here to describe the technical details of these measurements. For that purpose you should consult Commissioner Ewan Clague and the staff of the Bureau.

There are two conclusions which can be drawn from these data, no matter which series is used. The first is that World War II interrupted the general prewar trend in productivity. During the 2 decades between the wars, the annual rate of increase in output per man-hour for manufacturing averaged a little better than 3 percent per year. Over the 8-year period from 1939 to 1947, however, the average rate of increase was scarcely one-third as much. The great dislocation in peacetime industry caused, first, by conversion, and then later by reconversion, left manufacturing industries as a whole in 1947 at a productivity level far below the point which would have been reached had prewar trends been continued.

The second point is that the average postwar gain in productivity does not appear to be extraordinarily high. Our current estimates show an average annual increase from 1947 to 1953, ranging from 3.1 percent by one measure, to 3.6 percent by another. We find that World War I was followed by a recovery period, 1919–25, during which the average productivity gain was apparently well above 3.5 percent a year, even if a decline in 1923 is taken into account.

There is one more point which I must emphasize strongly. These averages which I have presented refer to manufacturing industries as a whole, and not to any particular industry. In actual fact, these averages represent many different rates of change in output per man-hour among the plants within an industry and among the industries, themselves. Our studies have shown that there are wide differences among plants and among industries.

Therefore, these figures must be used with great caution. They should not be applied to specific industries since there is a possibility, or even a likelihood, that any one particular industry might vary widely from this average.

Mr. Chairman, that completes any statement I may have.

The CHAIRMAN. Thank you very much, Mr. Secretary.

I would like to ask you just a few questions, and probably the members of the staff would like to ask some questions, too.

You indicate that your case studies show no layoffs or other serious unsolved displacement problems. Is it possible that the firms you visited are not entirely representative of the situation in all industries?

Secretary MITCHELL. That is conceivable, Mr. Chairman, and we hope, as we extend our studies, to take in more industries and perhaps find some that do not conform to what we have presently encountered. It is conceivable that there may be industries, or companies, that do not conform to the pattern we set down here.

The CHAIRMAN. Isn't it a fact, then, Mr. Secretary, that the reason that those workers who have been displaced from their jobs have not been a problem is because they have been in industries, you might say, big industry, where they were in a better position to keep them on the payroll and shift them around from place to place, until they got them adjusted and re-trained.

Small concerns, on the other hand, might not have been able to do that?

Secretary MITCHELL. That is conceivable, Mr. Chairman. I think that the point you make is right, plus the fact that the industries we have studied so far, which have introduced these technological improvements, have been industries, as I pointed out in my statement, which have been expanding in their business. They have been able to absorb the people in their expanded business.

There is one other point I think one should remember, that if you are talking in terms of automation narrowly defined, as I pointed out in this prepared text, the problem of installation, the cost of installation, is such an enormous one that up to now it has taken a fairly sizable business to use these techniques.

The CHAIRMAN. I think that is agreed by all the witnesses who have been before this committee, that only the large concerns will be in a position to use it to the greatest extent.

You don't know of any real displacement problems caused by automation, so far, do you?

Secretary MITCHELL. Well, I do not, Mr. Chairman. We have, as I said, these pockets of unemployment, but those cities in which we have such problems have been the result of sick industries, shall we say, for some long period of time. We have a chronic situation, which is not exclusively the result of technological change, or what might be called automation.

There are many other factors that enter into it. Certainly, when you look at the high level of employment, and the relatively low unemployment nationally, it is difficult to comprehend how great dislocations could be laid at the door of automation.

The CHAIRMAN. Well, suppose an organization decides to install a machine that will take the place of a large number of workers, be it business, the State, and the Federal Government.

Secretary MITCHELL. In the first instance, I think, Mr. Chairman, that every company has a responsibility to its workers to see to it that every effort is made, within the company, to provide employment in accordance with seniority, and all the other personnel policies that may exist. Certainly, I don't think we have come yet to the point in this country where workers should not be permitted to move around freely. We have devices built into our economy which protect the worker when he is involuntarily unemployed.

That is the reason I firmly believe that we should constantly strive for an adequate unemployment compensation program, so as to insure income during periods of shift, during periods when people may be moving from one job to another. But basically, in a large company that is expanding, as I tried to point out here, management has a real responsibility to its people to see to it that in planning for technological change the interests of the people are taken into consideration as much as the machine, or even more.

The CHAIRMAN. And the company has a responsibility of trying to take care of those workers?

Secretary MITCHELL. I would think so.

The CHAIRMAN. Don't you think the Government has the same responsibility, Mr. Mitchell?

Secretary MITCHELL. The Government, by virtue of unemployment compensation programs.

The CHAIRMAN. I mean for its workers.

Secretary MITCHELL. You mean Government employees?

The CHAIRMAN. Yes, that is right, Government employees. I didn't make myself plain.

Secretary MITCHELL. Yes, certainly, the Government has a responsibility for seeing to it that those people in its employ, who are doing a satisfactory job, should be protected. We have laws, civil-service laws, and we have regulations, which insure that the worker is protected.

The CHAIRMAN. Suppose that you decide that you can eliminate a certain number of workers in a certain division by using automation, and you don't have a place right then for those workers. Of course we are all in favor of progress and, strange as it may seem, we have not had one witness to appear before this committee who resisted automation, or genuine progress. Everyone has been in favor of it. They just want to make sure that the dislocations and displacements are taken care of in such a way that the workers will be provided for on the theory that society is being benefited generally by automation and progress, and that society, therefore, should make the impact less severe. On that theory don't you think that the Federal Government has the same responsibility to its employees as a large concern has to its employees?

Secretary MITCHELL. Certainly. May I add that the built-in protection of employees in Government from my own observation, in terms of civil-service regulations, and civil-service law, as passed by Congress, afford to Government employees a greater degree of job security and protection than most businesses afford to their employees.

The CHAIRMAN. Well, that brings up a point that is timely right now. It is about the plate workers over at the Bureau of Engraving and Printing. You probably know about that.

Secretary MITCHELL. I do.

The CHAIRMAN. I have a letter here from Mr. W. A. Rahn, chairman of the executive committee, Washington Plate Printers Union, Local No. 2, International Plate Printers, Die Stampers and Engravers Union of North America, AFL. I do not know Mr. Rahn. I never heard of the organization that he represents, until this morning I received a letter. But I will read it to you. It is addressed to me.

> On Friday, September 23, notices were issued to 48 plate printers employed at the Bureau of Engraving and Printing that their services as plate printers would terminate at the close of business on October 31, 1955. The reasons given for this action is a decrease of 40 percent in currency requirements since fiscal 1953 combined with an increase in currency production of 101.6 percent since 1949 due largely to added diligence on the part of plate printers aided by the use of technological improvements on the presses upon which currency is printed. While but a small portion of the estimated $1,350,000 savings contemplated for fiscal 1956 are reflected in the salaries of these 48 plate printers, the major part of this saving would still be accomplished if these men were not separated from their jobs.
>
> Our representatives accompanied by top officials of the A. F. of L. and Government Employees Council, A. F. of L., have exhausted every effort with Treasury and Bureau officials to avert this action before bringing it to the attention of Congress.
>
> Since this action was delayed until Congress was not in session, we respectfully request that you urgently appeal to Secretary of Treasury Humphrey to postpone this action to permit us sufficient time and an opportunity to present to Congress conclusive evidence certified by Ernst & Ernst that the action contemplated is not necessary, is most unfair, and may cause a serious shortage of highly specialized craftsmen in the not too distant future at the Bureau. We have gone to considerable time and expense to gather this evidence which reflects a more positive picture of the future than the thinking prompted by this shortsighted policy contained in the contemplated layoff of these 48 men to reduce the present high inventory of currency at the Bureau. There is more at stake in the operation of the Bureau, if it is to be operated efficiently, than the mere $400,000 the total savings of 48 plate printers' wages this year.
>
> Since there are so few days left before this action is to be taken on October 31, your most prompt attention will be greatly appreciated.

I did think it was timely that the Government should take a stand on this question, so I wrote Secretary Humphrey this morning. I sent him a special-delivery letter early this morning, and I am sure he received it by now. Therefore, I feel privileged to read the letter I wrote to him.

> DEAR MR. SECRETARY: It looks like the effect of automation is being felt on 48 plate printers employed at the Bureau of Engraving and Printing, the first in the Government. It is my understanding that they have been given notice that their employment will cease October 31, 1955.
>
> The Subcommittee on Economic Stabilization of the Joint Committee on the Economic Report, of which I am chairman, has been conducting hearings on the subject of automation, and such hearings are going on all this week.
>
> There is one thing I have been impressed with and that is the business or industry affected should retrain and take care of its employees, who are affected by automation. At the present time, automation is principally in the major companies and they are in the best position to take care of any displaced employees. It is my belief that it is just as much the duty of Government to take care of its employees as business or industry.
>
> The notice of termination of these employees brings the question before you for consideration. In other words, will Government attempt to do for displaced employees what Government will expect private industry to do with them?
>
> Pending this decision, which I am sure you will need some time to consider, I sincerely hope that you will cancel the notice of termination until the next session of Congress, which is a little more than 2 months off, can pass on the question. I believe you will agree that it is a major policy decision that Congress should bear some responsibility on, as well as the executive branch.

I am not going to ask you any questions about it, but I do sincerely trust, Mr. Mitchell, that you and the other members of the Cabinet, and those charged with administration policy, will give serious consideration to this. I believe it would be the first time that this particular question has come up—at least I haven't noticed it coming up before—and I believe it is very important that a policy decision be made if we are going to insist that business and industry take care of their workers. If we are going to expect that, I think we want to be consistent. While we don't want to block progress and we are not doing that, we want to take care of the workers by retraining them and placing them into other jobs, if at all possible to do so. I am sure you share my views in that.

Secretary MITCHELL. Certainly everything I stand for, Mr. Patman, puts the workers' interest in matters of these kinds at the top. It seems to me, and I am sure that you would agree, that it is also in the interest of Government to see to it that its operation is carried on in the most efficient, economical manner.

I am sure, too, that in accordance with the rules and policies of the Civil Service, these employees, or any other employees of Government, are given every opportunity for transfer to comparable jobs where they are available.

The CHAIRMAN. Mr. Moore, would you like to ask any questions?

Mr. MOORE. Well, as simply a problem of personnel administration, how should the introduction of labor-saving or labor-displacing processes be brought into the picture? What are the best personnel relationships in handling that?

Secretary MITCHELL. Mr. Moore, it seems to me that would vary by the company, by the type of change that is being made, and the question of whether or not there is a union in the company. There are many factors that would indicate that you do this on the basis of the facts as they are. Generally, it would seem to me that if you are going to allay this fear, which this word seems to create, employees who may be affected need to know, either through their union representatives, or directly, if there is no union, what the company's plans are, what they propose to do, how it affects the individual employee. I think the success of these companies which have introduced these labor-saving devices with a minimum of industrial relations problems, has been due to a recognition that the individual worker needs to know what the plans are. I think that is one of the cardinal principles in the introduction.

Mr. MOORE. You spoke of pockets of unemployment, and Mr. Reuther mentioned a phrase which seems to be going about, namely, that automation in Detroit means unemployment in South Bend. What can be done about these pockets of unemployment?

Secretary MITCHELL. There are many things that can be done, Mr. Moore. The Department of Commerce and the Department of Labor presently are trying to assist these communities. When I talk of pockets of unemployment, I am referring to those communities which have had chronic unemployment for a long period of time. There is no easy solution to that problem.

For example, in some of the coal-mining regions, where the problem is not the result of technological change, as such, or automation, but it is the result of new types of fuel, or the result of many things—there has to be, as I indicated here, a concentrated look at the problem by the community, by the State, and perhaps by the National Government.

Mr. MOORE. This question perhaps is one that Mr. Clague rather than you, Mr. Secretary, would want to address himself to. Several times during this hearing the distinction between production workers and nonproduction workers has come up. It disturbs me a little bit, because one of the first tasks in a beginning economics course is to try to get across the idea all work is "productive" if people are paid for it. That the Bureau of Labor Statistics should make this distinction, I am sure is based upon good and sufficient reasons.

I am wondering if you could explain what the distinction is in your statistics on this level?

Mr. CLAGUE. Yes, I would be glad to do that.

The production workers include those who are actually in the plant, including the skilled workers, and all others up to and including the management in the plant itself.

Mr. MOORE. Would a foreman be a production worker?

Mr. CLAGUE. A working foreman would be a production worker. The supervisory foreman belongs to management. We would include all the people in the plant, except the management people. I would like to check that to make sure about the foremen.

Mr. MOORE. If there were operators of say an air-conditioning system in the plant they would be production workers?

Mr. CLAGUE. They would be production workers. The kind not listed as production workers are those who are in the central office building, for example, where you might have the accountants and the research staff, if any, and the top sales staff, and people of that sort, who are not in the plant.

Now, the reason we draw this distinction is that these production workers are generally paid by the week, or by the hour. They are the ones whose man-hours are generally kept by the company. These other workers are on semimonthly or monthly payrolls, and are kept on a separate payroll by the manufacturer. So in collecting average earnings per week, or average earnings per hour, of the workers in the plant itself, we have to segregate these other types of workers.

We don't like the implication that these others are nonproductive. This term "production workers" has grown up over the years, and we have just continued to use it. We haven't found any other good term to distinguish them from what you might call overhead workers, who are productive, also.

Mr. MOORE. Would these so-called programers, for putting projects on to automatic punchcard systems in a plant, be production workers?

Mr. CLAGUE. Yes. They would be working right with the machines. Those we would count as production workers. It is the people who are in another place, for example, researchers doing laboratory research in another building. Those men would not be counted in our production workers.

Mr. MOORE. But custodial personnel on the other hand would?

Mr. CLAGUE. Yes.

Mr. MOORE. I suppose the distinction is then extremely arbitrary?

Mr. CLAGUE. It is convenient. In getting our employment figures, for example—by the way, we get both types of figures from employers—we separate production workers, the men who work by the hour and draw pay accordingly, so that we can develop statistics of earnings per week and per hour. We cannot develop such figures for the other workers because their hours are not kept separately.

Secretary MITCHELL. I think, Mr. Moore, it was my own experience that the distinction in a company is made on just this broad base that Mr. Clague outlined. You don't hear the words "production workers." You hear hourly rated, monthly rated, or weekly rated people. That is the distinction.

Mr. MOORE. As a former accountant, I understand the necessities for arbitrariness in such distinction as that between direct and indirect. That is, primarily, whether you can charge the cost directly to the product or whether it must, as a practical matter, be spread through some overhead burden-spreading process.

Mr. CLAGUE. In our studies we use the words "direct" and "indirect" somewhat differently. We find that in the plant itself when drawing up the man-hours of labor, you will have the direct-production worker, who is processing the material. Then there are machinists, custodial men, and a lot of other people who could be called indirect labor, but they would all be in this group of hourly rated workers in the plant. So we use a somewhat different distinction there.

The CHAIRMAN. Mr. Ensley.

Mr. ENSLEY. Mr. Secretary, the witnesses have indicated that in this process of technological development we are upgrading employees. They are moving to better jobs, requiring more skills and more technical training. How are we going to employ the people who make good routine workers, but may not have the basic stuff or the education or background for these more skilled positions?

Secretary MITCHELL. I think, Dr. Ensley, that we have always been confronted by that problem. You may recall the statistics I mentioned, which showed that the unskilled laboring groups since 1910 have been reduced, in relation to the labor force, quite dramatically. You might ask the question, what has happened to those people? They have moved, where possible, into higher skills; they moved perhaps into trade or service.

You might also ask what became of all the servants that people used to have, when it was said they cannot do anything else? They have moved into production jobs. It seems to me that the so-called unskilled worker will find a level, and our whole system of increasing basic education, and increasing training should be directed at employing a person at the highest potential skill that he has. There will always be, I believe, room for persons to exercise their highest potential skills, whether that be at the unskilled level or higher.

Mr. Ensley. The younger people can through education and reeducation develop skills, perhaps, but do you find from your studies that the older people—and by that I mean people 40, 45, or 50——

Secretary Mitchell. I hope you would not say that was "elderly."

Mr. Ensley. Are there unique problems in connection with automation that hits those particularly hard?

Secretary Mitchell. We haven't found them so far in connection with this narrowly defined automation development, but we received last year money from Congress to conduct studies on the employment of the older worker. I believe that industry has tended to look upon a man over 45 as not too good a risk in initial employment.

Our studies are going to be directed at comparable production records of older workers, or mature workers, at their absentee records, at the kind of jobs that they can do best, at the effects, if any, of pension plans, the effects the pension plans may have on company policy with relation to the employment of the older people. We hope as a result of these studies to be able to present to industry some facts about the situation.

The basis of our concern or study is not automation, but the fact that medical science has increased the life expectancy by some 18 years, I think, in the last quarter century. By 1970 or 1975 a sizable proportion of our available work force is going to be over 45. It seems to us in the Department of Labor that the present personnel hiring policies need to be looked at again to make sure that that potential work force is not neglected. That is the basis for our study.

Mr. Ensley. Will you release findings as a result of these studies soon?

Secretary Mitchell. We expect to, within 1956 sometime.

Mr. Ensley. Next year sometime?

Secretary Mitchell. Yes, sir.

Mr. Ensley. In easing the shock of technological development, you mentioned the important role of unemployment compensation. That is basically a State program, isn't it?

Secretary Mitchell. It is a Federal-State program; the determination of the amount of weekly benefits and the duration of such benefits is a State responsibility.

Mr. Ensley. Yes.

And the States in the last year have made quite a number of improvements, haven't they, in terms of benefits?

Secretary Mitchell. Yes. This spring I believe some 34 State legislatures acted, and in some form or another increased their benefits, or lengthened the duration of the benefits.

Mr. ENSLEY. I saw a memorandum recently that some staff member of your Department prepared, giving a very excellent rundown on the rather remarkable achievements this year. Do you believe however, that progress has been fast enough in light of the problems that may arise in the next 2 or 3 years in connection with automation and related matters?

Secretary MITCHELL. Well, the attention paid by the majority of the States this year is very encouraging. If they make the same kind of progress next year that they have made this year they will be a long way toward achieving the goal which President Eisenhower has set up, which is that the unemployment compensation benefits—public unemployment compensation benefits—equal at least 50 percent of the weekly wage for the great majority of claimants, which I think is an achievement goal.

Mr. ENSLEY. Does your employment service help place engineers, skilled workers, and technicians?

Secretary MITCHELL. Yes, quite generally, Dr. Ensley. I believe that we could be more effective in that field if employers were to use the employment offices in the States to a greater extent than they do for this type of professional or semiprofessional job. Many of them are now turning to the employment offices, because of the shortages, and we could be of more service if more employees learned to use the employment offices.

Mr. ENSLEY. I noticed in Los Angeles newspapers lengthy ads for skilled people, by New England companies. On the other hand I noticed in New England papers ads of California companies trying to entice engineers to California. I am wondering if the USES couldn't be more useful in that regard?

Secretary MITCHELL. We have the mechanism for interstate exchange of information. An employer who places a requisition in New York City, for example, for a job classification that is short, has a right to expect that if there are people available in Ohio he can get them through the New York City employment office, because there is this interchange.

Mr. ENSLEY. You have records as to the volume of such placement, do you?

Secretary MITCHELL. I believe we do.

Mr. ENSLEY. I think in England they have a service, do they not, of vacancies by companies? I suppose that wouldn't be at all practical in this country, but it has been, I understand, a very useful service in England.

Secretary MITCHELL. In England, as I understand it, the public employment offices have more mandatory authority over the movements of workers. The American worker moves freely and he should always be permitted to move freely.

Mr. ENSLEY. Another point that most all the witnesses have raised is that our rapid technological development will mean a shorter workweek. Could you make a forecast or prediction as to what the workweek might be, say a decade from now?

Secretary MITCHELL. On the basis of our present studies, I would be very brash, I think, to make any forecast as to what the workweek would be. I think it depends on the rate of technological change, and it also depends on our productivity needs. I mean, the need for national production.

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Certainly, we are going to meet the needs that the Nation has for the goods its uses.

Mr. ENSLEY. And it becomes a value judgment as to whether you wish more products or more leisure, under our free-enterprise system?

Secretary MITCHELL. And we have always, I think, made the right judgment.

Mr. ENSLEY. But it would be in the direction, I would suspect, of a shorter workweek?

Secretary MITCHELL. As I say, I think it is too early to say. I think that this will evolve through collective bargaining. While we have a standard 40-hour week, generally now, there are many companies in many industries that are working 36½ hours, 37½ hours, by agreement, I think it is an evolutionary thing, that collective bargaining will achieve.

Mr. ENSLEY. One of the implications of automation is the importance of education. On pages 5 and 7 of your statement you stress the importance of training and education.

Do you know, or do you have any feeling as to whether or not our secondary and primary higher educational systems are keeping abreast with the demands of our technology? There is coming up shortly a White House Conference on Education. A great deal of preparation is going into that. Will the Department of Labor make a presentation which, among other things, touches on the need for training people, to conceive, man, and, operate these technical machines?

Secretary MITCHELL. We have for many months, Mr. Ensley, been talking about this. As a matter of fact, we have a program in the Labor Department, directed to that very point. We are mainly concerned with assisting industry in its training problems in relation to the building up of skill, and the necessity for a larger percentage of skilled people in our work force.

Undoubtedly, trainability in a company has a rather direct relationship to basic education. There is no question about that. What we are dealing with now in industry are the defects, where they existed, of basic education, say, of 10 or 15 years ago, because you are dealing with people who are now in their twenties and thirties, and whatever defects or lacks they have is a result of basic education some 15 years ago. Certainly it goes without saying, in my opinion, that there is need for improvement of our basic educational system.

Mr. ENSLEY. I was in West Virginia recently and I was told that many of the high-school teachers of mathematics and science have never taken science or math themselves, and that partially as a result of that, there are fewer and fewer students taking those subjects.

This is something that gives us concern, particularly if we are going to develop technologically in the future.

Secretary MITCHELL. I might say on that point, Mr. Ensley, that in the armed services, where new skills and new techniques are being constantly required to service and operate new weapons, this problem of skills and training of soldiers is one of the most important ones the armed services have had to contend with. It is related, as we have found by investigation, to the basic schooling soldiers have when they come into the Army.

Mr. ENSLEY. I have 2 or 3 questions relating to the productivity or output per man-hour study that you summarized for us. As I understand, you will have the detailed study or report for inclusion in our record in the next 10 days or so?

(The information referred to appears at the end of Secretary Mitchell's testimony.)

Mr. ENSLEY. This, of course, is not the first time the Department of Labor has published a report on productivity, is it?

Mr. CLAGUE. That is right. The Department used to conduct studies of this sort and publish indexes of this kind before the war. As a matter of fact, we published them during the war also on individual peacetime industries, for which the individual industry data were considered satisfactory. But that did not include the big wartime industries at all. It contained very few of the durable-goods industries. So those studies were interrupted by the war. This is the first resumption of an effort to get an overall index for the manufacturing industries as a whole.

Mr. ENSLEY. This, of course, has tremendously important implications for industry and labor, and for economic forecasters.

Could you tell us a little of the process that you went through in consulting with industry and labor people in the preparation of this report?

Mr. CLAGUE. Yes. We have, in the Bureau of Labor Statistics, a Labor Research Advisory Committee, and also a Business Research Advisory Committee, consisting of representatives of labor and business. Needless to say, they have been following this work very closely during the period we have been doing it, during the last 2 or 3 years, so that we have had a lot of consultation and advice in connection with it. And, of course, lots of questions have been raised about it.

Mr. ENSLEY. By and large, though, they would see no objection to your agency preparing and publishing such data?

Mr. CLAGUE. Some of our critics think these figures are not good enough to publish. You will see that we have used four different measures. One of the reasons is that any one measure has some defects in it. We thought by multiplying the ways of approaching the problem we could, so to speak, get some notion of its general range.

This is not a figure that is as refined or as accurate as the consumer price index, for example, where we present one single figure and where we certify to its accuracy down to a few tenths of a point, or less. This is a more difficult thing to measure, for one thing. Productivity is the result of a good many factors, and it is hard to measure. So there are critics who say that these data are not as good as they might be, and they question whether they are worth while presenting on a par with our other data.

Secretary MITCHELL. I think it might be well to point out at this point, Dr. Ensley, that the inadequacies of the figures which Mr. Clague has been describing will be fully explained in the report which you get.

Mr. ENSLEY. That will be very helpful, of course.

I believe you indicated that the data come up through, including 1953.

Mr. CLAGUE. Yes.

Mr. ENSLEY. Do you recall what the study shows for 1953? Does it show a leveling off of productivity in that year somewhat?

Mr. CLAGUE. Yes. But I think we have to be careful about paying too much attention to any one 1year when we look at these figures, especially when we have a business downturn, followed by a business upturn, when we have a high level of employment and business prosperity, followed by a period in which there is an increase in unemployment.

Take an individual concern. It has the best results from a productivity point of view when it is using its machines at maximum capacity and has the right amount of labor to operate them. Generally speaking, it is doing well from an efficiency point of view when it is at capacity untilization of its machinery.

When you get a business downturn of some sort, however mild, it leads to some decline in production. They don't lay off the workers in the same degree that they let the machines down. Some of the production workers that Dr. Moore mentioned may be laid off in considerable numbers, but not the basic accounting staff and people of that sort, including repair and custodial labor. So the downturn in volume of production will have an adverse effect on the productivity of the individual firm.

However, the longer the production stays low, the more the company adjusts to that situation. It does lay off more people. It does gradually reduce its work force. It doesn't replace the people who quit. After about a year or so, or perhaps longer, you will find that the work force is down. Then when we get business recovery, production jumps quickly. But management doesn't immediately rehire the repairmen and the other staff services. So there may be ups and downs in the productivity figures which reflect business adjusting itself to business downturns and business recovery.

Mr. ENSLEY. So that probably, while you do not have data available for 1954, if you did have it available, it would show productivity picking up again at the end of the year as economic recovery got underway.

Mr. CLAGUE. Yes. Remember that 1954 was a year of comparatively low production, as compared to previous years. I wouldn't think there would be so much of a change in productivity in that year, because of the situation I described above. The average would reflect declining business conditions. However, in 1955, we had the typical business upturn from a moderate level of employment and production. Those are the times in which productivity would tend to show higher rates. Eventually, a little later on, the firms will have to hire all the additional staffs they need.

Then there will be a leveling off again.

Mr. ENSLEY. Will this study provide some kind of breakdown between and among industries?

Mr. CLAGUE. We don't plan in this study to show a break other than between durable goods as a whole—metal-goods industries and heavy industries—on the one hand, and soft-goods industries on the other. We have been publishing from time to time some few individual industry productivity data, but only where we are sure of the industry figures.

One of the weaknesses in the data is that the industries from census to census are not classified on a comparable basis. Therefore, some of the productivity figures on an industry-by-industry basis might be misleading. We won't try to publish them until we confer with industry and labor in those industries. We might decide to do some individual industries later on, but not in this report.

Mr. ENSLEY. Thank you very much. I might say, in connection with your productivity study, the chairman, Senator Douglas, has done a lot of work in the years gone by on this subject and has expressed to the staff several times the importance of this particular series, so he will be looking forward to your report with a great deal of interest. The material will be very helpful in our work.

That is all, Mr. Chairman.

The CHAIRMAN. Mr. Secretary, as a member of the President's Cabinet, I know you must be a very busy man. We, therefore, especially appreciate the fact that you were willing to give so much of your time and be patient with us in giving the benefit of your views to us. We appreciate it very much.

Secretary MITCHELL. I was very happy to do it.

The CHAIRMAN. Thank you, sir.

(The studies previously referred to follow:)

STUDIES OF AUTOMATIC TECHNOLOGY

No. 1—A CASE STUDY OF A COMPANY MANUFACTURING ELECTRONIC EQUIPMENT (OCTOBER 1955)[1]

United States Department of Labor, James P. Mitchell, Secretary

FOREWORD

This report is the first of a series of studies on the application of automatic technology. This study describes the introduction of automatic production methods at a company manufacturing electronic equipment. It describes the nature of the changes, indicates some of its effects on employment, productivity, and working conditions, and outlines some problems and methods of adjustment adopted by management and labor. Since only a single plant is covered the study is illustrative, rather than representative of the industry.

Similar studies are planned covering such major developments as the electronic computer, integrated machine processing, and automatic controls of operations. Some of the reports will contain, in addition to the detailed case study, some information on the extent of industry application of the specific type of automatic technology and on employment and related changes at plants producing new types of automatic equipment.

This case study is based largely on information collected in June 1955 by members of the Bureau's Division of Productivity and Technological Developments through personal interviews with company and union officials and from descriptive information published by the company. Background information was obtained from other Bureau studies and technical publications.—Division of Productivity and Technological Development, Leon Greenberg, Chief.

CONTENTS

I. Introduction.
II. Summary.
III. Industry background.
IV. Manufacturing operations at Y company.
V. Development of automatic production at Y company.
VI. Some implications for jobs and earnings.
VII. Stake of the company and its workers in automatic production.

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[1] Prepared by Edgar Weinberg under the direction of K. G. Van Auken, Jr.

Appendixes

A. Labor turnover rates in radio and television industry, 1950–55.
B. Employment in communication equipment and related products industries, 1947–55.
C. Description of some new jobs set up for automated production of electronics.
D. Select annotated bibliography on automatic production of electronics.

I. INTRODUCTION

An important example of the general trend toward more automatic production processes is provided by the recent changes in methods of manufacturing electronic equipment. The substitution of mechanical for hand labor in various assembling operations is likely to have an important impact on the number, skill, and wages of persons employed in this large and growing industry. Moreover, since the use of electronic devices is one of the main features of automation in both office and factory, changes in their manufacture have an impact far beyond the industry itself.

This report describes the introduction of certain new automatic production techniques in the Y company, one of the first manufacturers of electronic equipment to use these techniques for commercial purposes, chiefly in radio and television sets. It is intended to give a factual account of the background and nature of the new methods, the process of change, and their implications for jobs and wages in one company. Although the history of these changes doubtless varies from company to company, depending on economic conditions, union policies, and methods, this description of one case should be useful in suggesting the general character of developments that may occur at the plant level as the new methods are adopted elsewhere.

This case study is not intended to assess the impact of automatic production methods on employment in the industry as a whole. But to enhance its value to the reader, some general background information on the characteristics, and some recent economic and technological experience of the industry is also presented here.

II. SUMMARY

The experience of the company under study suggests the possibility of an orderly transition to automatic technology, within the framework of amicable union-management relations. This company is an expanding one in an expanding industry. It has apparently been able, through good planning and good timing with respect to general economic conditions, to introduce new developments and resolve certain problems of worker adjustment with comparatively little hardship.

Automatic production methods were developed gradually over several years as part of the company's continuous efforts to raise productivity, to improve the quality of its products and to expand output and sales. Introduction of the new methods in favorable economic circumstances apparently avoided any displacement of workers. Some unskilled job opportunities were eliminated; certain new machine operations employing somewhat higher paid labor were created; and some additional jobs in skilled occupations were opened. Many hand labor jobs still remain. As the company pursues its program of expansion, rising output may eventually offset the effect of labor savings per unit on employment opportunities.

III. INDUSTRY BACKGROUND

Automation of the manufacture of electronic equipment concerns an important and growing sector of the economy. An average of 490,000 employees, according to BLS employment statistics, were employed in 1954 in the communication-equipment industries, a broad group covering plants making not only radio and television, electronic tubes and related products, but also telephone and telegraph, phonograph records and miscellaneous communication equipment. The radio, phonograph, television, and electronic tube branches comprise about 85 percent of this total.

Employment characteristics

About 2 out of 3 employees in the communication equipment industry group are located in the States of Illinois, New Jersey, Pennsylvania, New York, and Massachusetts, chiefly in the metropolitan centers. Women comprised 47 percent of total employment in this industry group in December 1954, a much higher proportion than the 26 percent in manufacturing as a whole. Compared to the average for manufacturing, labor turnover is fairly high. A majority of electronics workers are employed in relatively large plants; in October 1952, about 67 percent worked in plants with 500 or more employees with only 9 percent in plants with less than 100 employees.

A noteworthy feature of the industry is the wide seasonal variation in activity. Additional workers are hired in the fall as new models are introduced in preparation for the winter season. Activity slackens in the spring and layoffs increase. (See appendix A, table I.) Employment in 1954 varied by 10 percent between November, the peak month, and April, the low month.

Since the beginning of World War II, the communication equipment industry group has been expanded very substantially, though somewhat irregularly. The wartime employment peak, over 400,000 in 1944, was about 4 times the 1939 level. Employment declined to a postwar low of about 279,000 in 1949. (See appendix B, table II). Between 1949 and 1953, the postwar peak, employment virtually doubled in contrast with the rise of only 22 percent for manufacturing as a whole. Average employment in 1954 was about 12 percent lower than in 1953, but still somewhat larger than the 1952 employment level. Employment in the first half of 1955 was slightly higher than in the corresponding period in 1954.

The most important factors in the trend of employment in recent years have been the rapid growth of television production and the heavy purchases of military electronic equipment. Over 7 million television sets were produced in 1950, in contrast with only 179,000 in 1947. Production in 1954 was over 6 million sets. About 40 percent of the industry's workers, in mid-1953, according to a BLS study of electronics labor force (Monthly Labor Review, October 1953) were engaged in defense work. This proportion has since been reduced.

As employment and output were increased in the postwar period, manufacturers reduced man-hour requirements, lowered prices, and improved the quality of their product. Direct man-hours required for the production of televison sets were reduced, for example, by about 20 percent between 1949 and 1950, according to a BLS study of plants in the industry (Trends in Man-Hours Expended Per Unit: Television and Radio Sets, 1949–50). Mass-production techniques found useful in radio manufacture—for example, greater specialization, simplification of design, improved handling devices, and better plant layout—resulted in faster manufacturing operations.

Business observers and students foresee continued long-term growth of electronics goods production. Military, industrial, and consumer demand for communication and control equipment is expected to provide the basis for steady expansion. Of special significance for the industry's future are the heavy expenditures for scientific research. According to a BLS survey (MLR October 1953) "extensive research and development has been partially responsible for the rapid growth of this industry during the past few years, and is a necessary condition for its future growth."

Recent technological developments

Traditionally, electronics manufacturing has largely involved the hand assembly of numerous wires and small parts. Mechanization of assembly proceeded slowly because of difficulties in devising mechanisms to duplicate hand movements, for example, in cutting, twisting, spacing, and soldering a mass of wires into electronic circuits. The tremendous demand for output for military and civilian purposes is creating wide interest in faster methods of production.

A major step toward reducing hand assembly work in this industry has been the complete redesign of electronic circuitry. Instead of connecting, lacing, and soldering wires together by hand, manufacturers are adopting various methods of mechanically printing or stamping circuits in the form of metallic (silver or copper) lines on flat boards made of glass, ceramic, or plastic. The complex three dimensional network of wires is thereby converted into a pattern on an easily handled flat surface.

Simplification of assembly work was first introduced during World War II for various types of military equipment where space and weight had to be kept to a minimum. Within the last 5 years a number of manufacturers have substituted printed circuitry in place of conventional wiring in commercial radio and television receivers, hearing aids, control devices, and other electronic equipment. According to Fortune magazine (June 1955) printed-wire circuits are now being produced at a rate approaching a million a month, compared to almost none 5 years ago.

The use of simplified printed circuits has stimulated interest in developing automatic machinery to insert electronic components such as resistors, condensers, wire jumpers, and tube sockets. Within the past 2 years 2 machine-building companies and several electronic equipment manufacturers themselves have perfected inserting machines. Such specialized devices, operating like large staplers, go through a cycle of operations without human intervention (except for manual pushbutton starting and stopping) and are therefore described as "automatic."

A few machines are already being used and several others are now being tested. One machine costing over $100,000 has been delivered for use in building a large scale computer for the Air Force. According to one industry authority (see Business Week June 18, 1955) assembly machines will be at work in three of the biggest TV-radio companies by the end of the year, and in many more firms by the end of next year.

A more advanced development involves the complete redesign of various electronic components to facilitate assembly by machine. The United States National Bureau of Standards' project Tinkertoy (sponsored by the Navy's Bureau of Aeronautics) demonstrated the possibility of fabricating and assembling electronic components in a series of integrated and mechanized operations. The building block or modular principle of design was used in producing capacitors and resistors and assembling them into finished products. So far only one company has started the production of television sets using this advanced approach. Further progress of modular design would involve important changes for suppliers of electronic components as well as assemblers of radio and television sets.

IV. MANUFACTURING OPERATIONS AT Y COMPANY

The Y company is one of the largest manufacturers of radio and television sets. Activities at the company's half-dozen electronic equipment plants consist chiefly of the engineering, assembling, and marketing of radio, television, and phonograph sets in a variety of models from portable radios to radio-television and phonograph combinations. Some work is also done in the field of military electronics. Components in standard specifications are generally purchased from suppliers, built into subassemblies and completed chassis which are finally installed in variously styled cabinets made by the company itself. The engineering staff selects the parts required and determines plans for assembling.

Assembly-line methods, with a considerable amount of job specialization, have been the dominant features of the company's manufacturing operations, although they were modified with the introduction of automatic production. The methods in use prior to that time are described below.

Component parts, after inspection, were moved by push truck from the storeroom to bins located at work stations on the assembly lines. Subassembly parts requiring intricate wiring operations were produced at stations apart from the main assembly line. These units were later attached to the chassis or metal frame of the set on the main assembly line. Before the chassis on which the parts were mounted goes to the assembly line, metal parts such as tube sockets were attached in the riveting department.

The main assembly line at one of the company's plants consisted of a table extending 300 feet with workers seated at intervals along each side. Nearly all of the workers on the line were women. Each worker on the line performed one or more repetitive operations such as wiring, soldering, or lacing on each set, or inserted components in a predetermined sequence and in a more or less set time. Hand tools such as soldering irons and pneumatic screwdrivers were used. One operator, for example, soldered the ends of two particular wires to specified parts on each set. Each worker was assigned operations requiring about the same time cycle. Upon completion of her operations, the worker pushed the jig on which the workpiece was set, slanted at 45° angle, diagonally across the table to the next work station where another worker performed a different operation.

The completely wired chassis was moved off the main assembly line by conveyors to the tubing line where television tubes were inserted. The sets were then electrically tested and the rejected ones put aside for repair and adjustment. After testing, the set was moved by conveyor to the installing and packing department where the chassis was bolted into cabinets, tested, and packed for shipment.

Building a television set under conventional methods often involved handling several hundred parts and soldered connections. Nearly 60 percent of the direct labor time spent on a set made several years ago was for wiring, lacing, and

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assembling; the rest was for riveting of parts, installing the chassis, testing and adjusting and packing.

The company's management asserts that it has constantly endeavored to meet the keen competition in the electronics industry by improving the efficiency of plant operations. More conveyors, simplified work stages, and incentive pay plans were installed and time and motion studies were made over the years to speed production. Industrial engineers of the methods-improvement staff are responsible for finding new areas and ways for cutting costs and improving efficiency.

V. THE DEVELOPMENT OF AUTOMATIC PRODUCTION AT Y COMPANY

Greater automatization of production methods at Y company has involved the introduction of two new manufacturing operations: The production of printed circuit boards and the operation of automatic inserting machines. Hand assembly operations are reduced but not eliminated. The new methods only indirectly affect the riviting, tubing, installing, testing, adjusting, and packing operations, which remain largely manual activities.

The Y company installed these new techniques in two stages over a period of several years. A printed circuit board was substituted for many hand wiring operations in making radio subassemblies in 1952. The insertion of components through holes punched in the board, however, continued to be done by hand. Two years later, the company introduced a mechanical device for inserting a number of components on a printed circuit for television sets.

Printed circuits.—In adopting the printed wiring technique, the company first set up a special laboratory and experimentally tested various known techniques for producing an electrically conductive metal design on an insulating material. The engineering department finally decided on a photoetching process which is widely used in this field. This involves the use of a standard silk screen process to print an acid-resistant wiring design on thin copper foil bonded to the plastic board. Changes in circuitry can be made by altering the design to be printed. A number of boards are printed at one time. The board is then immersed in an acid etching bath and the unprotected metal is removed, leaving a pattern of copper wiring. Holes for inserting components and wires are punched by machines. Such processing of boards of all types is carried on in one plant.

The boards used in the process are purchased from plastic manufacturers who also cut the boards into panel sizes that fit Y company's particular needs. After photoetching of the design at Y company, the printed circuit board is inspected, and retouched if necessary.

The first use of these printed circuits was on five-tube portable radios in 1952. Components were inserted by hand on the board and the underside dipped in molten solder to complete the subassembly. These boards were pretested in over 250,000 sets, with only 24 boards returned to the factory for replacement. In 1954, the company decided to use photoetched circuit boards in its 1955 television receivers. About 50 percent of the circuitry was printed on the boards. In the 1956 design, about 75 to 80 percent of the wire circuits are incorporated on the printed circuit board.

Automatic inserting machine.—Work on developing a mechanism to attach components automatically to a printed circuit board was begun by the company's engineering staff in 1953. At that time, none of the machine-building companies now making assembling machines had models on the market. Within a year, a machine was perfected by the company to insert components at the rate of 6 boards per minute. The prototype of the machine was built at Y company's plant but work on parts of later units was contracted to outside machineshops.

This mechanism consisted of a battery of air-powered heads, including staplers, arranged in a line, 30 feet long. Located below the heads, a conveyor carries the printed boards, positioning each successively in the proper station. Wired resistors, etc., are automatically stapled and tube sockets and similar components snapped into prepunched holes on the printed circuit board. About 60 assorted components are automatically chute-fed to the heads and inserted on the board, some simply, some two at a time, and some three at a time. Before fastening wired components, the inserting head trims wire leads to size and crimps them precisely to contact the copper patterns on the boards. Boards are automatically moved on the conveyor from station to station on the machine unit with different components inserted at each station. Whenever the machine fails to feed a component correctly, a red light signals the failure and the entire machine automatically stops.

Since conventional resistors, capacitors, etc., are designed to fit the requirements of hand assembly methods, company engineers worked with supplying manufacturers to modify the packing of resistors so that they could be more easily and quickly fed into the factor inserting machines.

The company has continued to make improvements. The first units could insert components at the rate of 6 boards a minute; 1 now used can do 12 boards a minute. At first, the machine design was somewhat inflexible; later improvements made it possible for the machine to use components of various sizes. In addition to 4 units now in use, the company plans to install 2 others, 1 approximately 100 feet long.

So far, only one other large producer of electronic equipment has been licensed to use the machine. Despite some demand from other producers of television receivers, company Y is undecided about producing such machines for the market. Although production of such machinery offers the company an opportunity for diversifying its activities, such new interest outside the company's primary function of assembling and marketing electronic equipment would introduce new problems of business policy.

Manual operations.—Although automatic inserting covers an important part of the assembling process, a number of operations are still done manually. Tubes are inserted on the board by hand because they are too fragile or bulky for the machine. The wire connections on the underside are made fast by hand dipping in molten solder to complete the circuit of a subassembly unit. After the processing of the boards and attaching of components by machine are completed, the boards are then shipped to a central plant for hand wiring of the remaining 20 to 25 percent of the circuitry and inserting of the remaining components, attachment of printed circuit boards to chassis, and for final installing of the picture tube. This work is done on an assembly line. After visual and electrical inspection and testing, and assembly in the cabinet, the completed set is then moved by conveyors either into storage or to packing for shipment to dealers.

Economies and costs of automatic production.—Printed circuitry and automatic inserting machines make possible significant increases in efficiency and improvements in quality. They are designed partly to reduce labor time and space requirements for assembling television and radio receivers. Improvements are still being made in the construction and operation of the new equipment and the full extent of the savings still remains to be determined. The degree to which the potentialities of the new techniques are achieved depends largely on the amount of downtime that may be necessary for repairs and maintenance. In addition to operating savings, it is believed that automatic production methods mean "absolute quality control of television production." By testing a printed circuit as a single entity, for example, 25 to 30 individual checks, where human error may enter, are eliminated.

Some increased costs resulting from greater mechanization must be taken into account in evaluating the changes. Development of the printed circuits and automatic machinery, according to company estimates, cost over $1 million, spent over several years. Automation has substantially increased the company's consumption of electric power. Finally, since the company was among the first to adopt printed circuits, it was necessary to undertake a costly educational campaign on the subject among dealers and a training program for service. One result of this investment, apparently, is that the later innovators in industry will be spared this cost of winning consumer acceptance of these changes.

VI. SOME IMPLICATIONS FOR JOBS AND EARNINGS

The decision to use automatic assembling machines for making TV sets in conjunction with printed circuits was made by the executive vice president in the spring of 1954. The vice president in charge of production informed the production foremen concerning the changes about 2 weeks or so in advance of application. The officers of the local union were also told in advance that the company was trying to improve production procedures. Workers learned of the changes via the grapevine. The new methods of production, like other efforts of manufacturers to increase efficiency, involved certain adjustments in the number, skill levels, and earnings of Y company workers.

Displacement of workers.—No employee, according to company officials, was laid off as a result of the change in production methods. "Management is aware of its social responsibilities," one official asserted, "and seeks favorable economic conditions for introducing changes." Moreover, the company tries to take advantage of seasonal fluctuations and high turnover among its women employees to avoid displacing workers from their jobs as new methods are installed.

Thus, the Y company introduced new production techniques in July 1954 at a time of model changeover and of employment expansion. Employment at the company plants in the first half of 1954, the period preceding the innovation, had been considerably below the 1953 employment level largely because of the decline in consumer demand. In the last half of 1954 the company increased employment, and persons on seniority registers still seeking jobs were called back to work. Hiring slowed down seasonally in the first 6 months of 1955. With the seasonal upturn in August 1955, the company again sought additional workers and placed help-wanted advertisements for assemblers, lacers, and wirers in the daily newspapers.

Fewer persons were employed in the first half of 1955, however, than in the corresponding 1953 period. The lower level of employment in 1955 is attributed to a sharp cutback of Government defense purchases. Another factor is the increased efficiency in the use of labor which makes it possible to expand television production without increasing employment proportionately. As the company continues to expand its activities, however, it believes that a rising output should eventually bring employment to its earlier higher level.

Employment and earnings on automated jobs.—An important result of adopting printed circuitry and automatic inserting machinery was to create a number of new machine-tending jobs. In the production of printed circuits, new job classifications, such as silk-screen operators, processors (printed circuits), circuit board scrubbers were set up. (See appendix C for description.) In the operation of the inserting machine, new classifications—automation machine tender, automation machine operator, and automation assembler—were opened.

No greater skill or training seems to be required on the new jobs. A training period of only 2 weeks given by the developmental group, was necessary. In contrast to the continuous repetitive manual operations on the assembly line, these jobs involve starting and stopping and observing the operation of machinery. Vacancies on the new jobs were posted in accordance with union agreement and workers were selected by foremen according to seniority and ability to perform duties. Some preference was expressed for male workers.

Pay rates for the automation jobs were set at 5 to 15 percent above the straight-time hourly rates for unskilled assembers because of some differences in working conditions and increased responsibility. Job-evaluation techniques were applied to some extent in arriving at a first approximation of the wage rate. All rates for new production worker jobs were subject to negotiation with the union.

Employees who process the printed circuit board up to the point that it is fed into the automatic inserting machines are put on an individual incentive-pay basis. Some of the workers in the final assembly line are also paid on an individual incentive basis; others are on a group basis. None of those who operated the automatic insertion equipment, however, are covered by an incentive-pay program.

Skilled and technical employment.—Skilled jig and fixture men and related skilled workers were hired for work in developing the inserting machine in the company's model shop. Employment in this group was more than doubled and some additional apprentices were taken on. Besides developmental work, which occupies most of the labor time of these skilled workers, they also have the responsibility of repairing and reconditioning the machines.

Accompaniing greater mechanization has also been some expansion in the employment of engineers. The development of automation on television sets resulted in a doubling of the industrial engineering staff. The number of mechanical and electrical engineers has also been more than doubled over the past 5 years and the ratio to production workers has increased. These engineers work not only on improving production methods but also on redesigning sets and planning new products. At the time of the study the company was seeking mechanical designers, electrical engineers, and technical writers.

Employment in manual operations.—The installing of automatic production methods also meant reorganization of assembly lines with reduction in overall requirements for hand wirers, lacers, and assemblers. These jobs are held chiefly by women. Some workers were reassigned to final assembly, inspecting, packing, and related operations, as well as to the newly created automation jobs. Since printed circuits actually result in a lighter set, women can now be assigned to certain packing jobs, hitherto not open to them.

Where hand assembly lines for completing the insertion of components on a board were modified, the engineering department was generally responsible for determining the duties and the flow of work while the foreman selected and trained the workers. The modified line was run alongside the former line for a test period of about a month, without any incentive rate. After some of the difficulties had been smoothed out, the company's time study men determined the production standards required for bonus payments.

Employment at suppliers.—Plants supplying material for the automatic methods, according to Y company officials, have found it necessary to increase their employment. Thus, several companies producing copper foil for bonding enlarged their facilities to take care of the increasing demand for printed circuits. The need to modify the form of components created tasks for design engineers at component manufacturers. To produce the company's assembling machine, one small outside machine shop under contract tripled its employment. Some of these shops received engineering aid from Y company. (No information could be obtained concerning employment changes in plants producing wires, etc., used in the conventional type of circuitry, but no longer used in printed circuits.)

VII. STAKE OF THE COMPANY AND ITS WORKERS IN AUTOMATIC PRODUCTION

Greater automatization of manufacturing methods, from the company's point of view, is a way of achieving important advantages in a highly competitive market and hence beneficial to both the company and its employees. Lower production costs, partly as a result of savings in unit labor requirements made possible some reduction in the prices of the company's television sets. Since labor costs are actually a small proportion of the total cost of assembling a television set, relative to material costs the company may not have considered the labor-cost savings the most important factor in deciding to make the change.

Since the company was among the earliest to adopt the new techniques, it has made its progressiveness in production methods a basis of sales promotion. Automation is featured therefore in the company's sales literature as a way of making available to consumers sets with large screens at no higher prices than small ones; improving the quality of set performance; and providing greater ease in servicing sets. The company claims that "circuits are simple and trouble free, with greater resistance to vibration and jarring, as well as to extremes of temperature and humidity."

The future, according to the company officials, is likely to see automatic production methods extended. Larger inserting machines are planned. One official believes that eventually a machine will be perfected to insert such complex items as tubes. Transistors which are smaller, less fragile and more easily handled by machine than vacuum tubes may become commonplace in the near future.

With greater productive capacity the company is seeking to improve its position in the electronic-goods industry. It is trying to expand its share of total sales of radio and television sets. Along with changes in its production methods, the company recently made improvements in its marketing facilities: opening a new warehouse and increasing the number of distributing branches throughout the country.

Particularly noteworthy are its efforts to diversify production. The company recently added, for example, high-fidelity phonographs to the list of products made in its electronic plants. A plant for research, development, engineering, and production of fiber glass was recently completed. It is trying to obtain additional contracts for electronic aircraft equipment where lightweight, small size, and ability to stand shock are important considerations.

Finally, the company expects to expand in the near future with the introduction of color television sets. A substantial enlargement of its color television research laboratory is contemplated. The president of the company in his 1954 annual report forecast that color television receivers will enter the first production phase in the fourth quarter of 1955. Although such sets are more complex, the company expects to be able to produce and price them for the mass market. By 1956 and 1957, he believes, color TV sales should reach major proportions.

In brief, the company looks upon automation as the latest step in its continuous efforts to reduce operating costs and increase efficiency in order to meet competition. Automation along with diversification and operating improvements is apparently conceived as part of a broad program of long-range growth, a measure for expanding the quality and quantity of output rather than for contracting employment.

The new methods apparently have been accepted by the workers so far as part of the normal process of shop changes. The agreement between the company and the local A. F. of L. union is noteworthy in this connection. It became effective October 1, 1954, 3 months after the installation of the new production methods, and extends for 2 years. No mention of automation is made in the new agreement. The changes are governed by the work rules—covering technological changes in general—of the 1952–54 agreements which were in force prior to the introduction of the new methods.

One of the opening paragraphs of the agreement, for example, vests in the company sole rights, in its judgment, to hire, fire, lay off, transfer, and promote employees, to increase or decrease operations, remove or install machinery, determine work processes and procedures. Layoffs, promotions, etc., however, are to be made on the basis of seniority, provided that the employee concerned possesses sufficient skill and ability to perform satisfactorily any new work to be done. The title, pay scale, and description of all job vacancies in a plant must be posted for a 2-day period. If no employee applies, the company may fill the job as it deems fit. Seniority is limited to status at a plant, and is not companywide. Within a particular geographical area, however, interplant transfer of seniority rights is permitted.

Both the 1952 and 1954 agreements require that prior to establishing a new job classification, the union be advised of the pay rate the company wishes to apply, with the rate subject to negotiation. Incentive pay rates on new jobs are set by time studies made by the company. Employees have the right, however, to question the findings and to take up disagreements through the grievance system.

Summing up their general attitude, the union officials indicated that automation, continuing technological progress of the past, is likely to benefit workers as a group and therefore was not causing the union any unusual alarm. The union is mainly concerned that its members obtain a share of the gains of new mass-production techniques and therefore strives to increase wages and related benefits. It also wishes to minimize the hardship suffered by individuals, whether temporary or more enduring.

Appendix A.—*Labor turnover rates in radio, phonograph, television sets, and equipment industry, 1950–55*

[Per 1,000 employees]

Year and month	Accession rate	Quit rate	Layoff rate	Year and month	Accession rate	Quit rate	Layoff rate
1950	73	25	14	1953	50	30	12
January	65	18	24	January	71	31	3
February	63	18	20	February	54	29	5
March	66	19	23	March	54	33	8
April	61	19	13	April	49	28	8
May	67	21	17	May	44	28	4
June	72	19	10	June	60	33	9
July	88	15	6	July	46	28	6
August	127	30	3	August	63	37	2
September	96	37	6	September	61	42	10
October	90	39	7	October	45	29	13
November	54	34	14	November	29	22	39
December	29	25	28	December	18	16	32
1951	60	28	20	1954	34	15	17
January	65	27	25	January	30	16	36
February	65	26	5	February	35	14	23
March	66	32	9	March	34	14	18
April	44	28	65	April	24	13	24
May	56	32	52	May	21	13	25
June	55	27	26	June	38	11	17
July	43	23	25	July	37	12	6
August	65	32	15	August	52	19	6
September	93	35	3	September	46	22	9
October	82	32	7	October	40	17	13
November	56	26	7	November	32	16	15
December	33	21	15	December	23	12	15
1952	63	28	8	1955	----------	----------	----------
January	63	28	14	January	30	13	18
February	52	24	12	February	31	13	9
March	50	25	14	March	34	17	22
April	43	25	20	April	31	16	16
May	43	23	12	May	38	18	16
June	60	23	9				
July	56	22	2				
August	96	33	2				
September	92	43	2				
October	85	36	2				
November	69	29	3				
December	50	25	7				

Source: U. S. Bureau of Labor Statistics.

APPENDIX B.—*Employment in communication equipment and related products industries, 1947–55*

[In thousands]

Year and month	All employees	Production workers	Year and month	All employees	Production workers
Annual average:			1954	490.1	353.3
1947	336.1	249.1			
1948	314.1	225.8	January	505.6	365.4
1949	279.3	197.6	February	495.5	357.4
1950	350.7	270.4	March	492.6	354.2
1951	405.8	307.1	April	483.4	346.4
1952	474.2	356.6	May	470.5	334.7
			June	466.4	329.3
1953	556.0	419.9	July	468.1	331.9
			August	483.7	347.7
January	556.0	427.0	September	495.5	359.9
February	565.8	435.6	October	505.3	370.1
March	570.4	437.0	November	511.0	373.5
April	566.5	433.0	December	504.1	366.6
May	560.4	424.9			
June	551.6	415.5	1955		
July	540.8	403.9			
August	560.3	421.1	January	495.0	358.3
September	566.5	426.6	February	494.1	358.1
October	562.2	423.1	March	491.1	352.3
November	548.0	408.5	April	491.3	350.2
December	523.7	382.1	May	492.4	350.0
			June	499.7	356.5
			July	502.0	355.6

Source: U. S. Bureau of Labor Statistics. The communication equipment and related products industries (SIC 366) include the following industries: radios, radio and television equipment (except radio tubes), radar and related detection apparatus, and phonographs (SIC 3661); radio tubes (SIC 3662); phonograph records (SIC (3663); telephone and telegraph equipment (SIC 3664); and communication equipment not elsewhere classified (SIC 3669). BLS monthly employment statistics are not available for these industries separately.

APPENDIX C. DESCRIPTION OF SOME NEW JOBS SET UP FOR AUTOMATIC PRODUCTION OF ELECTRONICS

1. AUTOMATION MACHINE OPERATOR

Operates radio or television automation machines to insert and fasten production parts on circuit boards. Requisitions and expedites production parts to maintain production schedules. Receives production orders for required number of circuit boards and allocates machine time to produce required units. Tabulates production records and arranges for lot shipment to designated production areas or locations. Requests machine adjustments to correct substandard work.

2. AUTOMATION ASSEMBLER

Loads prepackaged or bulkpacked supply of production parts into automatic feed channels of radio and television automation machines. Checks completed circuit boards for missing or loose parts and makes insertions or repairs as necessary. Matches color codes, reads production part numbers and uses simple hand tools.

3. AUTOMATION MACHINE TENDER

Operates radio or television automation machines to insert and fasten tube sockets, resistors, jumper wires and condenser on circuit boards. Clears operating mechanisms, removes jammed part, and restarts machine, making simple adjustments as required. Rethreads machine with jumper wire. Uses simple hand tools.

4. STAGER

Checks prepared plates for bubbles, blisters, and unexposed areas prior to etching operation. Touches up imperfections, using paint and brush. Scrapes excessive printing as necessary.

5. SPRAYER—PRINTED CIRCUITS

Sets up and operates a spray gun to spray lacquer on prepared surfaces with commercial type finish. Cleans and adjusts spray gun. Assists in other production operations as required.

6. MACHINE OPERATOR—PRINTED CIRCUITS

Operates a variety of short cycle machines to prepare, expose, and etch production parts for predesignated lengths of time. Scrubs, sensitizes, and etches parts with nontoxic solutions of prepared strengths. Assists in other printed circuit operations as required.

APPENDIX D. SELECT ANNOTATED BIBLIOGRAPHY ON AUTOMATIC PRODUCTION OF ELECTRONICS

1. Automatic Production for Electronics, Electrical Manufacturing, July 1954 (a description of various methods of automatic assembly).
2. Lee, L. K. and F. M. Hom, Automatic Production and Electronic Components, Radio and Television News (Radio-Electronic Engineering Edition), December 1953 (an analysis of possible approaches to automatization of electronic equipment production).
3. Lessing, L. P., Automatic Manufacture of Electronic Equipment, Scientific American, August 1955 (pp. 29–33) (an up-to-date description of the electronic module system).
4. Machine Automates Assembly of Printed Electronic Circuits, Automation, April 1955 (pp. 65–68) (a description with text and pictures of a recently introduced machine for attaching components).
5. Haines, N. R., Automation in the Electronic Manufacturing Industry (Stanford Research Institute, Stanford, Calif., August 17, 1954) (a description of company developments with some discussion of implications).
6. Now, Assembly by Machine for TV Sets, Business Week, June 18, 1955 (pp. 58–60) (a summary of current and prospective developments in various companies).
7. Electronics Employment and Labor Force, Monthly Labor Review, October 1953 (pp. 1049–1054) (presents valuable information on employment and occupational composition).
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STUDIES OF AUTOMATIC TECHNOLOGY

NO. 2—THE INTRODUCTION OF AN ELECTRONIC COMPUTER IN A LARGE INSURANCE COMPANY (OCTOBER 1955)[1]

United States Department of Labor, James P. Mitchell

This report is the second of a series of studies on the application of automatic technology. This study describes the introduction of an electronic computer in a large life insurance company. It describes the nature of the innovation, indicates some of its effects on employment, productivity and working conditions, and outlines the methods of adjustment adopted by management. Since only a single establishment is covered the study is illustrative, rather than representative of the industry.

Similar studies are planned covering other major developments. Some of the reports will contain, in addition to the detailed case study, some information on the extent of industry application of the specific type of automatic technology and on employment and related changes at plants producing new types of automatic equipment.

This case study is based largely on information collected in September 1955 by members of the Bureau's Division of Productivity and Technological Developments through personal interviews with company officials and from descriptive information published by the company. Background information was obtained from other Bureau studies and industry publications.—Division of Productivity and Technological Developments, Leon Greenberg, Chief.

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[1] Prepared by K. G. Van Auken, Jr.

CONTENTS

Foreword.
Summary.
Background.
The classification sections of the X division.
Planning for the Computer.
The techniques of installation.
The effects of the computer on the classification sections.
The Electronc Installations Division.
Outlook.

Appendix

A. Growth of life insurance personnel in the United States, 1948–53.

FOREWORD

The large electronic digital computer has been variously hailed as the salvation of the overworked office, and decried as a serious threat to the job security of the white-collar worker. Stimulated, in great part, by electronic computation techniques devised for military and scientific purposes during the war and early postwar years, the electronic computer is now slowly appearing in major office installations across the United States.

The use of the electronic computer in the office, however, was preceded by a period in which the major elements of the computers designed for scientific use had to be adapted to the requirements of commercial usage. Scientific computers were designed to make a large number of highly complex calculations with great speed based on a relatively small amount of data put in the machine. Now, computers have been adapted with considerable success to use relatively few and less complex calculations in processing huge masses of data with equal speed.

Brief mention should be made of that segment of industry which manufactures digital electronic computers, for in its undoubted growth it will represent a new area of employment opportunity. This is a young industry, but in 1954 its dozen or so establishments have shown an estimated $50 million worth of sales or leases of digital computers. It has also been estimated that by 1957 there may be as many as 400 large electronic computers in commercial use; a sizable increase over the number currently in business hands.[2]

The Bureau is now seeking additional information on the growth of the computermaking industry in order to assess more accurately its effect on employment and specialized manpower requirements, and to more nearly determine its approximate trend. Fragmentary evidence of employment increases in the industry was recently reported to the Bureau by a large computer manufacturer. The computer division of this company reported that between 1951 and August 1955 its employment had grown from about 300 to about 700 employees.

Today we see electronic computer installations in those enterprises which by their nature require the rapid and accurate processing of an ever-growing amount of data and information; among these are mail-order houses, large manufacturing firms, public utilities, and life-insurance companies. According to the Controllership Foundation, 5 of the 15 large electronic computers now being used in business are to be found in insurance companies.[3] This does not mean that the insurance business per se has some unique or complex quality that especially lends itself to the use of a computer, rather it simply indicates that an increase in the quantity of routine paperwork here, perhaps more than in other areas, is a controlling factor in using electronic techniques.

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[2] Electronic Data Processing Industry, 1955, American Management Association, New York, N. Y., pp. 231–234.

[3] Electronics in Business, July 1955, Controllership Foundation, Inc., New York, N. Y., pp. 157–160.

Formal recognition of electronic computing devices came in 1948 when the Society of Actuaries appointed a committee to examine the new techniques and report to the membership. By the fall of 1952, the committee concluded that:

(*a*) Electronic machinery suitable for day-to-day use in a life-insurance office had become available;

(*b*) Such machinery would permit substantial reductions in operating costs and space requirements; and

(*c*) To employ the machinery most effectively, a basic reengineering of insurance-office procedures appeared indicated.[4]

A large life-insurance company was selected by the Bureau for detailed study because the industry was using a relatively large number of computers, and thus had longer experience in the study and use of electronic-computer methods. Consequently, it was felt that the experience of a company in such an important and growing area of office work would more nearly encompass the many problems of timing, personnel effects, training, and adjustments incident to major technological change.

The growth of life insurance in force over the past decade and a half, especially during the postwar period (over 30 percent between 1948 and 1954) underscores the mounting pressure felt in that part of industry to find new and better methods of data processing. Total employment in the life-insurance industry, reflecting the growth in work volume, rose at a more rapid rate from 1948 to 1953 than the average rise for all nonagricultural industries during the same period 13.9 percent and 11.8 percent, respectively. Although women comprised about 33 percent of the life insurance work force in 1953, they represented 66 percent of total employment in home offices, where all large computer installations have been made.[5] Thus, as will be seen in the case study, women workers in this industry were among those most affected by the electronic computer.

SUMMARY

This report presents a case history of the effects of the introduction of a large electronic computer in the home office of the ABC Life Insurance Co. The ABC Co. underwrites a large volume of diversified kinds of insurance.

The company planned most carefully for the computer, not only in the technical aspects, but in the sensitive field of human adjustment to change. The importance of the latter aspect is made clear by the fact that the computer was to replace in great part the jobs of 133 persons in the classification sections of the company's X division. These persons were not laid off; they were interviewed with a meticulous concern for their job preferences in other areas of the company, and except for normal turnover were or will be successfully placed elsewhere. The changes are not yet complete.

The 2-year period required between initial computer installation and the final resolution of its operations allowed the company the time required for a gradual transition of personnel. The employees who were to be affected were told of the computer in advance; no attempt was made to gloss over employment effects in the section to be affected. The selection of persons to work with the computer was handled in a forthright manner, and in general the mechanics of introducing the change was exemplary.

However, certain factors which contributed materially to the success and ease of the adjustment may not prevail among all establishments now considering the use of an electronic computer. These are, first, the company's growth to meet an expanding volume of business; second, a shortage and relatively high turnover of female clerks in the company's home office area; and finally, the basic similarity of job requirements among many of the company's divisions permitting easy transferability.

BACKGROUND

Early interest in mechanization

The company has for a great many years been interested in mechanization as a means of controlling operating costs. Recurrent shortages of office labor over the past 15 years, especially in the lower grade clerical occupations, has caused company officials to become even more interested in methods of mechanizing office operations. Conventional office machinery was used extensively during the early

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[4] Report of the committee on new recording means and computing devices, September 1952. Society of Actuaries, Chicago, Ill.

[5] Life Insurance Fact Book, 1955, Institute of Life Insurance, New York, p. 47.

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postwar years, and as interest in other methods grew, the executive vice president in 1948 appointed a committee of company officials on a part-time basis to look into the possible applications of the then-developing computers to company activities. This group followed the work being done by major developers of electronic computers.

Clerical employment

Despite the productivity increases arising from latest punched-card methods. the company during the postwar period had been plagued by an almost continuous labor shortage. While company employment remained fairly constant in the period 1951–53, nevertheless the expansion of business consistently kept a jump or so ahead of the number of people available to carry it on. A high proportion of the company's office employees are girls recently graduated from high school. Company experience with these unskilled clerical workers has led to the rule-of-thumb that a new graduate will stay with the company on the average about 3 years and that there will be an almost complete turnover of all female clerks every 5 years. This results from the fact that most young women in this age group are not seeking careers but rather are filling in time until marriage or in some cases until other employment opportunities come their way.

Personnel policies and practices

The company has maintained a consistent policy of not discharging or downgrading personnel because of technological change. Employees understand that new methods of performing the work will not affect their job security, since there is always a department or division in the company to which an employee can be transferred when a new device obviates her current job. So acute has the shortage of office labor been that many of the company's operating divisions have hired high-school students for part-time work for the past several years.

Most new employees, especially the high school graduate clerks, are hired through the personnel division. Here they are given aptitude examinations and when found qualified are assigned to the requesting activity. For jobs requiring extra skills, candidates who have demonstrated their ability to think logically and express themselves well are trained to build up these skills. The unskilled high school clerk starts at the lowest rated job ($44 per week) with seniority increases, aside from promotion increases, generally given at the end of 6 months, and annually thereafter. Seniority increases are dependent to some extent on performance rating. Satisfactory employees earning under $70 weekly reach the grade maximum within 3 to 7 years, while those earning over $70 per week require 7 to 10 years to reach the grade maximum. Twice a year an employee is given a performance rating by her immediate supervisor; in which all aspects of the employee's work are considered and given a numerical rating. Promotions are based on seniority, performance, qualifications, and attendance.

THE CLASSIFICATION SECTIONS OF THE X DIVISION

Functions

The work of these sections consists principally of the preparation of business operating statistics. They produce and maintain running inventories of all policies in force, classified by policy amounts, age of policy, and other factors for the six lines of insurance written. Each classification must be totaled to achieve class balances, with about 50 percent of the work being done on a monthly cycle and the balance on a weekly cycle. In addition, the sections prepare experience rates of mortality based on data reported to the company, and calculate the company requirements for fund relations.[6] None of their work directly involves any customer servicing. They use only data and information which come from other operating divisions.

Workload and equipment

In an average month, the classification sections process data from approximately 850,000 policies on which some transaction has occurred (death claims, policy changes, etc.). The data are reported on punched cards prepared in other company divisions and in its two head offices. The work involved—sorting, classifying, and performing calculations—was, before the innovation, performed with the latest punched-card equipment. In the process 125 separate punched-card machines were employed (not counting incidental key punch machines) and about 3¼ million punched cards were used each month. The operations involved required the movement of many separate decks of punched cards from one machine to another and required careful control and checking. As a result many paper records carrying intermediate answers and listings of policies were produced to verify that processes were being accurately applied—and to arrange for appropriate corrections when they were not.

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[6] Fund retentions are the sums of money which must be held by the company in order to meet the legal requirements which vary according to such characteristics as the type of insurance plan, the amount of insurance, and the age of the policy, to mention but a few.

More than 90 percent of the equipment was applied to sorting, classifying, and summarizing operations. The total rental for the 125 machines amounted to approximately $235,000 per year just prior to the innovation. The company regarded the operation as a highly efficient one; it had been extensively studied and modernized.

Employment

The X division employs approximately 800 people. The routine data processing of this division over the years had been centralized and mechanized so that of the 800 people, 198 worked in the areas directly affected by the introduction of the electronic computer. In the areas not affected the people are generally engaged in work requiring experience and value judgments—work which cannot readily be mechanized. These persons were scheduled to work one 8-hour shift 5 days per week (37-hour week after deducting lunch and recreation time). In the X division, as elsewhere, the problem of labor shortage was most vexing. For the 3 years preceding the introduction of the computer, the division's employment had grown about 10 percent as the volume of work mounted. Notwithstanding this increase in staff and the part-time employment of a considerable number of high school students, overtime was necessary to maintain schedules, particularly in the classification sections. The employees of this division are not represented by a union.

PLANNING FOR THE COMPUTER

As mentioned earlier, the company had had a longtime interest in mechanizing routine office calculation work. In 1948 a committee of company officers was formed to investigate the possible application of the electronic computer to office work. This committee functioned on a part-time basis and some of its work was in part paralleled by an industry committee of insurance executives who also followed closely the developments in the field of electronic calculators. The company committee was assisted in its work by two subgroups—a subcommittee of systems and procedure people drawn from various company divisions and another group comprising members of the X division who had considerable experience with mathematical computing techniques.

The installation group

Not until early 1953, however, did the committee receive a proposal from the X division subgroup—later to be called the installation group. This proposal recommended the purchase of an electronic system for use in the classification sections of X division. After the committee approved the recommendation, the chief of X division (a vice president who was also chairman of the committee) asked the installation group to assemble further data necessary for a recommendation to the president of the company and also to determine preparations necessary for installing the electronic equipment. They planned the procedures necessary to replace the punched-card methods and made estimates of potential saving, as well as of the probable effect on personnel of the introduction of the electronic computer recommended. Satisfied with the indications obtained from these studies, the chief of the X division recommended to the company president the acquisition of the electronic computing system for the work of the classification sections.

The decision

A key factor in the final decision to purchase a large computer was undoubtedly the installation and successful operation of a similar computer in the Bureau of the Census, United States Department of Commerce. The other part of the decision was in naming the classification sections of the X division as the spot for installation. This latter part of the decision was based on a number of points. First, the classification sections were not in direct customer servicing; therefore experimentation in this field would not jeopardize long-standing relations with customers. Secondly, the high degree of mechanization in these sections meant that less developmental work would be required than in converting wholly manual clerical procedures. Finally, the burden of work in these sections was constantly mounting in the face of increasing personnel shortages. From the company's point of view, the total decision was also based on what its executives considered to be sound economics in an expanding firm, and a recognition of the high probability of successful machine use coupled with a desire to move forward in gradual steps. Thus, in mid-1953 the board of directors approved the recommendation of the chief of division X.

THE TECHNIQUES OF INSTALLATION

During the first months of 1954 the installation group worked steadily to plan for the coming of the electronic computer. This included all phases of technical planning beginning with the physical rearrangements necessary for the receiving and location of the computer itself. Additionally, an officer of division X met regularly with personnel officers to discuss the many personnel matters, principally the transfer of personnel, which they knew would arise out of the computer's installation.

In April 1954, just before the required space rearrangements were started, the chief of the division gathered the members of the classification sections in an informal meeting and told them of the coming of the computer and of the reasons which prompted this action by the company. He answered questions put to him and reiterated the company policy that no person would lose his job or salary level because of new work techniques. As reported by a company official, the general reaction among the employees of these sections was one of interest and understanding, along with a natural amount of concern regarding their new assignments.

Trial period

When the installation of the computer was completed in late June 1954, a few representatives of the computer company remained to help those operators selected to work on the computer in activities essential for its most efficient operation. Eight keymen who had previously been given from 1 to 6 months of special training by the computer manufacturer formed the nucleus of the new staff.

One of the major workloads in the classification sections had been the task of data sorting. A formal trial period from June through October 1954 had been arranged earlier in order to give the computer a full test in this critical workload area, because experience with electronic computers indicated that sorting limitations had been one of their chief drawbacks. It became apparent early in the trial period that the sorting problem had been overcome and that the major task facing the company was the gradual shifting in processing method from the punched card to the computer's magnetic tape.

The shift was accomplished by first having separable pieces of work performed in duplicate using the old and the new techniques, and then discontinuing the old method. The amount of duplication in each work phase differed ranging from a minimum of 1 month (a work cycle) to a maximum of 3 months (3 work cycles). Thus the shift proceeded in discreet steps.

While the trial period was in progress, an article in one of the company's home office publications, timed to coincide with the computer's initial operation, described its possibilities and limitations. Through this medium, all company employees learned of the computer's arrival and were told in straightforward terms that some employees in the classification sections would be transferred to other divisions. The article also skillfully reiterated the company's policy that even this newest technique would not cause any personnel separations. Following the publication of this article, a similar article appeared in another magazine aimed at company's field staff.

As the trial period progressed, it was found that the information contained on 850,000 punched cards could be recorded on 71 reels of magnetic tape. The need for making paper records of intermediate results, for example subtotals, to control accuracy practically disappeared. In addition to the large computer, 6 new auxiliary machines and 21 standard punched card machines were required in the accomplishment of the sections' work, but this represents a very significant reduction from the 125 machines formerly used. As a result, rentals of punched card equipment are expected to decline to about $19,000 per year.

Prior to the trial period the company had established certain definite criteria which the computer was to meet before its acceptance, for example, the sorting mentioned earlier. All of these having been met, the computer was officially accepted in late 1954.

THE EFFECTS OF THE COMPUTER ON THE CLASSIFICATION SECTIONS

The employment effects on the classification sections of this division were considerable. The 198 persons formerly required to carry out the function in the areas directly affected are to be reduced to 85 by June 1956 when it is expected that the installation will be complete and free from the many problems which arise from the introduction of so highly complicated a device. The persons who have been or will be affected by this change were handled individually and considerately by management.

Selection of computer employees

In selecting the employees to operate the new equipment, every effort was made to use persons from the classification sections. Some of the new positions, however, involved skills and knowledge not obtainable from the group whose work was being changed. The 20 persons required to operate with the new equipment were recruited as follows:

From the classification sections of the X division	9
From other sections of the X division	5
From other company divisions	5
From outside the company	1
Total	20

The selection criteria established for the new jobs were experience, proficiency in mathematics, and college training, if any. The latter criterion was considered desirable but not essential, and some of those finally selected were not college graduates. The person recruited from outside was an electronics engineer who had formerly been employed by the computer manufacturer. The company had been unable to find within its organization a person who met the technical standards for this job.

Reassignments

Those not selected for computer operation weren't transferred at once to other divisions; they were released gradually, as they completed duplicate work cycles, after a careful review and evaluation of the individual's record and a personal interview. Each interview requested that the person give her job preference for transfer and in no case was anyone asked to accept a lower paying job. From the time of installation in June 1954 to September 1955, 106 persons had been released from the classification sections. The results of these releases are shown below:

	Men	Women	Total
Transferred to other jobs within the X division	7	65	72
Transferred to jobs in other divisions	2	13	15
Retired		1	1
Resigned (14 marriages, 2 jobs in another company, 2 moved to other areas)		18	18
Total	9	97	106

Those persons released were transferred to jobs for which they, with former work experience, required only a small amount of on-the-job training in order to be completely acceptable to their new work groups. For example, there are 15 other punched card sections in the home office utilizing personnel of approximately equal skill. In all cases, the supervisors to whom the released persons were transferred were consulted in advance, had an opportunity to interview the transferees, and are currently satisfied with the transfers. Although 72 persons were transferred to other jobs within the X division, a combination of normal personnel turnover and general expansion of business showed the division to be 10 percent understaffed at the time of this study, in September 1955.

Supervisors

Within the original group of 198 persons in the classification sections, there were 6 supervisors who had built up considerable skills in the art of handling people. The 4 who were most interested in the electronic computer are now permanently assigned—3 in computer operation and 1 in development. One other indicated a preference not to remain in this field and was transferred to an equivalent staff job in another division. The remaining supervisor was offered and accepted a higher paying, non supervisory job.

The computer work force

The computer work force consists of the following 20 persons:

Job title	Total	Men	Women
Supervisor (engineer)	1	1	
Computer operator [1]	2	2	
Assistant computer operator [1]	2	2	
Tape librarian	1		1
Auxiliary equipment section head	1	1	
Converter team head	1		1
Converter clerk	1		1
Assistant converter clerk	1	1	
Junior converter clerk	3	3	
Key-punch operator	1		1
Card and tape file clerk	1	1	
Machine-room distributor	1	1	
Control captain	1		1
Assistant control captain	1		1
Control clerk	2		2
Total	20	12	8

[1] 1 operator and 1 assistant for each shift

This staff works on the regular 37-hour workweek with overtime as needed. A second shift, 5 days a week, is utilized in order to achieve maximum results from the computer. Only 2 persons are employed on the late shift.

The procedure development group

The group assigned to develop the new procedures required for use with the new equipment consisted of 14 persons until early in 1955, when it was reduced to 9 persons. The distribution of the present staff is as follows:

Job title	Total	Men	Women
Senior project analyst	2	2	
Project analyst	3	3	
Assistant programer	2	1	1
Flow-chart clerk	1		1
Assistant coding clerk	1		1
Total	9	6	3

Originally this group also included 1 senior programer, 3 programers, and 1 flow-chart clerk. These five persons were transferred to the newly created electronic installations division earlier this year.

The procedure development group, being concerned with results and procedures, and the programing of these techniques, was faced with a heavy initial job in adapting the workload of the classifications sections to the computer. However, it is expected that after June 1956 only 4 of the 9 persons now assigned to this group will remain as its normal complement. The five persons released will be moved at once to the newly created electronic installations division which is eagerly looking for skilled manpower in the computer and allied fields. More about this new division later.

Training the computer staff

As mentioned earlier, a nucleus of the staff was trained by the computer manufacturer prior to the installation. The ABC company had considered giving more or less formal training to all employees selected for the staff, but based on the experience of the first few trained and the company's early negotiations with the computer manufacturer, it was decided that on-the-job training would be best for most of the staff.

Wage-structure changes

The following tabulation of the wage structure before and after the installation of the computer shows the extent of upgrading involved:

Approximate annual salary	Number of employees							
	Originally in classification sections		Released or to be released for other assignments		Assigned to the computer operations		Expected in new classification sections [1]	
	Men	Women	Men	Women	Men	Women	Men	Women
$2,500		4						4
$2,800		6		1				5
$3,000		35		30				5
$3,200		35		28	1	1	1	8
$3,400		52		34				18
$3,600 [2]	3		3		1		1	
$3,700		9		4				5
$4,000		16		9	3	2	3	9
$4,300		8		3	1		1	5
$4,600	1	12	1	11		1		2
$5,000		7		3		1		5
$5,400		1		1		2		2
$5,800		3		1		1		3
$6,700		1		1				
$7,200	1		1		2		2	
$7,600	2		1		1		2	
$8,100					2		2	
$8,500	1		1					
$9,000 and over	1				1		2	
Total	9	189	7	126	12	8	14	71

[1] Includes, in addition to the 20 employees in the computer group (9 of whom originally worked in the classification sections, the other 11 coming from outside those sections), the 56 classification sections employees who were retained on noncomputer duties, and the 9 employees in the procedure development group.

[2] Nonclerical labor.

NOTE.—As a result of the installation, it is expected that 21 punched-card machines and 85 employees (at an average annual salary of about $4,200) will manage work which under former methods, required 125 punched-card machines and 198 employees (at an average annual salary of about $3,700).

Job content of new staff

As mentioned above, the procedure development group, soon to level off at 4 persons, is primarily concerned with seeking solutions to specific problems within the framework of the computer's capabilities and programing these solutions in the form of directions to the operational staff. The operational group (an operator and an assistant on each shift) actually run the computer. The tape librarian stores the magnetic tapes on which the data have been entered. The auxiliary equipment section of the operational group converts current transaction data on punched cards to magnetic tape, and in addition, performs the same function on those punched cards reporting new policies. All maintenance and repairs of the computer and other equipment is performed by the computer manufacturer's representatives.

Cost effects

The computer installation will reduce the number of punched-card machines within the sections from 125 to 21 with an accompanying decrease in annual machine rentals from $235,000 to $19,000. Wage and employee-benefit costs will also be substantially reduced by the cut in personnel from 198 to 85 persons. It will free more than 15,000 square feet of floor space for other activities. The principal saving in supplies is the reduction of monthly punchcard requirements by nearly 2½ million.[7]

These savings are partially offset by the amortization charges against the computer, the regular maintenance fees paid to the computer manufacturer, and the costs incident to the about 4 percent "down time" of the computer because of mechanical failure.

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[7] The reduction in the number of punchcards required the purchase of 1,000 reels of magnetic tape, which, however, unlike the punchcards, may be erased and reused.

The net effect of the computer on the classification sections is expected to be a 50-percent saving in the sections' budgets. Related to the cost of operating division X, it amounts to about a 9-percent saving for the division as a whole.

THE ELECTRONIC INSTALLATIONS DIVISION

By the end of 1954, the suitability of electronic computers to office work had been substantially established. To expand the use of equipment of this kind was recognized as a task requiring a major company effort. Accordingly, effective January 1, 1955, a new division was formed under the executive direction of a vice president—the electronic installations division. The person who headed the studies which led to the initial recommendation to acquire the computer and who arranged for the installation was placed in direct charge of the new division.

This division was established for two primary purposes, first, the company was satisfied with its initial computer experience and needed a formal group to plan for extensions of this technique and, secondly, the company wanted a pool of manpower skilled in the use of electronic computers within one division in order to implement its future plans.

The division chief, with the rank of vice president, formed the electronic installations division in company with eight men who had had some prior experience in the field. In the following months, the division was increased by 21 persons, 13 of these were selected because of their prior experience with specific phases of company business, and the others were clerical assistants. In June 1955, a review was made of all home office personnel to develop a list of persons who had the experience and educational background required for work within this highly specialized division. Such persons were invited to take three examinations which would indicate, to a degree, their aptitudes for this work. More than 250 persons responded, including members of practically every division in the company. As of September 1955, 30 persons had been selected from this list. The criteria established for selection recognized, in order of importance, company experience, seniority, and aptitude ranking. Since the division would be dealing with procedures in practically all divisions of the company, the selections were made in such a manner as to have persons with experience in as many company divisions as possible included in the new division.

The 60 persons now comprising the electronic installations division are heavily weighted with those having skills or aptitudes in the fields of programing, project analysis, and other logical processes. Included are some who will be trained for operating a large computer. In June 1956, when the current installation is expected to be substantially completed, 5 of the 9 persons in the procedure development group previously referred to will be transferred to the electronic installations division to help in its major functions.

Thus, the electronic installations division has become a new source of employment within the company, with prospective additions required as new computer programs progress. Aside from being an excellent source of personnel replacement for going computer installations, the division will plan all aspects of future computer installations.

OUTLOOK

The company, through the vehicle of the electronic installations division, envisions a program of more than 3 years in which every division will be carefully analyzed and studied to determine whether or not a computer installation would make substantial cost savings or help reduce the effects of present labor shortages in its functions. As this time, 22 company activities are being examined carefully within the framework of a 3- to 5-year program of planning for possible computer installations; 12 of the 22 projects are now in the process of preliminary planning, and 10 are yet to be considered.

The principles which will be applied in the studies involved in these 22 projects are those stated in the September 1952 report of a committee of the Society of Actuaries:

1. An electronic computer should be applied to the whole job, not to some separately departmentalized piece of it.
2. Small jobs should be combined with others.
3. Source records should be consolidated.
4. Make all calculations at one time.[8]

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[8] Op. cit. (pp. 22–23).

It is estimated that it takes 1 to 1½ years to develop plans for a specific company activity, and following this 1 to 5 years to implement these plans through final, problem-free installation. It is obvious that the company will use electronic computers in many activities which will have a direct bearing on the company's customers. The performance of the computer in the classification sections has proved satisfactory to the point that such use is clearly feasible. Moreover, the economics of the computer has recommended it for increased use. One of the prime requirements set by the company for its first computer, which cost in excess of $1 million, was that the computer must return total investment within 5 years. The company has found, however, that actual investment will be returned in about 4 years.

Based on these excellent financial results and the experience of an orderly, and carefully planned transition of its employees, the company undoubtedly will use additional computers in the future.

Studies have not been completed to the point where it is in a position to definitely determine the effects of electronic devices on the duties, salaries, and composition of its home office staff outside of the X division. Research reports so far indicate, however, that the reduction in clerical requirements will be very largely in the lower clerical levels—positions filled mainly by young ladies who stay with the company a comparatively short time, doing a large volume of simple, repetitive transactions—the work areas for which electronic machines are suited. It does not expect electronic devices to affect the substantial number of positions requiring judgment and experience.

The home office is currently operating with a staff of about 14,000 people, which is at least 1,000 short of current requirements. A clerical shortage of varying degree has been characteristic for many years. The company's experience indicates that present demand for clerks (particularly for work of the kind adaptable to electronic processes) is in excess of the supply. Added to all this is the current expanding volume of business.

Under the circumstances it does not expect to have any personnel separations because of the extended use of electronic machines. As indicated before, the great majority of positions affected by such machines are those occupied by unskilled clerks during their early period of employment. As these positions are replaced by computers, the rate of hiring can be reduced, if necessary. Moreover, by reducing the number of unskilled clerks required, candidates for more skilled positions can be released from their present assignments, thus permitting the establishment of more positions requiring experience and judgment—positions which cannot now be established because of the acute clerical shortage. In any event, where the position of an employee is discontinued, it is the announced policy of the company to offer such person an acceptable position at no reduction in salary.

APPENDIX A.—***Growth of life-insurance personnel in the United States, 1948–53***

[In thousands]

	1948			1953			Percent change in total 1948–53
	Total	Women		Total	Women		
		Number	Percent of total		Number	Percent of total	
All employees	326.3	107.2	32.9	371.5	121.5	32.7	+13.9
Home office	106.1	70.3	66.3	118.1	78.5	66.5	+11.3
Agency cashiers and clerks	35.6	31.8	89.3	39.9	35.9	90.0	+12.1
Agency managers and assistants	28.6	.1	.3	37.7	.4	1.1	+31.8
Full-time agents	156.0	5.0	3.2	175.8	6.7	3.8	+12.7

Source: Life Insurance Fact Book, 1955 (Institute of Life Insurance, N. Y.)

TRENDS IN OUTPUT PER MAN-HOUR AND MAN-HOURS PER UNIT OF OUTPUT—MANUFACTURING, 1939-53

United States Department of Labor, James P. Mitchell, Secretary; Bureau of Labor Statistics, Ewan Clague, Commissioner

FOREWORD

This report presents the first set of indexes of output per man-hour and man-hours per unit of output in manufacturing as a whole published by the United States Department of Labor's Bureau of Labor Statistics since 1942, when trends covering the period 1919 to 1939 were presented. The dearth of statistical information which resulted in interruption of this program during World War II was relieved by the availability of data from the 1947 Census of Manufactures, from subsequent annual sample surveys and from Facts for Industry Series. These have been supplemented with data from other sources. A particularly significant contribution of data to one aspect of this work came from the Bureau's study of interindustry relationships.

It would be almost impossible to list all the individuals who have contributed directly or indirectly to this report and to the work of the past 3 to 4 years which underlies it. One who must be mentioned, however, is the late Samuel Weiss, who gave much valuable advice and guidance on methodology and standards when he was Chief of the Bureau's Office of Statistical Standards.

This report and the indexes presented herein were prepared in the Bureau's Division of Productivity and Technological Developments, under the general supervision of Leon Greenberg, Chief.

The physical output measures were under the direction of Allan D. Searle, assisted by Julian Frechtman, Enzo A. Puglisi, and Mary L. Kelly.

The net output measures were under the direction of Jack Alterman assisted by Edgar Weinberg.

The Bureau gratefully acknowledges the assistance on selected production indexes of staff members of the Federal Reserve Board.

Finally, acknowledgement is due to the members of the Bureau's advisory committees—business and labor who were often consulted during the course of the project and whose comments have been most useful.

INTRODUCTION

Importance of measures of output per man-hour

One of the most important factors in the growth and strength of the American economy, perhaps the keystone of the American standard of living, has been the long-term rise of what is popularly known as "productivity." It has been estimated that much of the increase in goods and services produced in the economy during the past half century has been due to this rise in productivity rather than to the increase in the number of man-hours worked.[1]

The implications of productivity change are closely associated with many of the current problems and interests of businessmen, workers, professional economists, and Government policymakers, including problems of economic stability, expansion and adaptation, employment opportunities, technological displacement, occupational obsolescence, increased earnings, and shorter hours. It is possible to scratch away at bits and pieces of these problems and to engage in guesswork about their implications. To study them intelligently, however, to evaluate their overall impact, we must resort to some general kind of quantitative examination of a key factor common to all of the problems and interests—namely, productivity.

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[1] Frederick C. Mills, Productivity and Economic Progress, Occasional Paper 38, National Bureau of Economic Research, Inc., New York, 1952.

The meaning of productivity in relation to the study of economic activity is well understood by most practitioners. Yet, because of its sometimes dramatic connotations, the word "productivity" has often been loosely applied and even more loosely interpreted. Although it may be very simply stated as the ratio of output to input, it is necessary to define specifically each side of the ratio. Since there are many different ways of defining both output and input, many different types of productivity ratios are, at least theoretically, possible. The choice of definition should be dictated by the potential use of the measure—often tempered by the problem of obtaining adequate data.

The productivity ratios which have been found most useful in analysis of the economic factors thus far mentioned, as well as others, are those which relate output to man-hours (or the reciprocal ratios of man-hours to output). Other measures, such as output per unit of capital equipment, may also be useful; but a man-hours ratio takes account of the utilization of human beings—the ultimate resource of production.

It is necessary that persons who use this kind of ratio for whatever purpose recognize clearly that it is a resultant of many factors in the productive process. It (and all other productivity ratios as well) may be affected in varying degree by the rate of application of new (or old) technology; by improvements in plant layout, work methods, work flow, materials-handling procedures, and other applications of management techniques; by changes in volume of production; by new products or materials; by the skill, effort, and incentive of the work force.

An understanding of the effects on the economy of war and postwar changes in technology, and their relationship to current interests and problems, requires productivity measurements for the total economy, and for its broad sectors as well—e. g., manufacturing, mining, agriculture, trade, and service. Estimates which give some indication of the trend in productivity for the economy as a whole (private gross national product per man-hour) serve a useful purpose when employed in conjunction with other indicators to provide a general picture of current changes in the economy.[3]

There is a need for a better understanding of what lies behind the economywide estimate because such a measure may obscure divergent trends in output per man-hour among different sectors of the economy. An index of gross national product per man-hour, among other things, is affected by shifts in relative importance among various sectors. Specifically, an increase in relative importance of the low (high) labor requirements sectors will have the effect of raising (lowering) the trend of private gross national product per man-hour.

This implies that estimates of output per man-hour are needed for as many sectors as possible. As a first step in this direction, the Bureau of Labor Statistics has developed estimates for manufacturing—one of the most important sectors of the economy. About 35 percent of all nonagricultural employees are in manufacturing industries. It is here that the most intensive and dynamic applications of technology have occurred in the past, and where technological development will continue to play an important role in the productive process. Moreover, much work has been done on the manufacturing sector for past periods and, generally, more statistical data are available for this sector than for many others. These are important facts connected with the problems of constructing measures of trends in output per man-hour and in analysis of their current implications. The interpretation of current trends is usually sharpened by comparing them with long-term and cyclical developments of the past, and frequently this is the only way in which such trends can be placed in proper perspective.

History of the Bureau's program of productivity measurement

To understand the implications and uses of productivity data it may be useful to review some of the history of work in this area by the Bureau of Labor Statistics.

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[3] See section on Private Gross National Product Per Man-Hour (p. 318).

A major factor in the long-term growth of productivity has been the dynamic character of technology. Its early development generally was the introduction of machines to perform what previously had been done by hand. As early as the 1890's, the first Commissioner of Labor studied this problem of substitution and published reports on the relative output of machine versus hand labor in the manufacture of various commodities. In later years occasional studies were made in specific industries.

A most striking characteristic of technology in the 1920's was the widespread adoption of formalized management and mass production techniques. During this period of time, the need for historical analysis of the influence of these techniques and of technological change was recognized and the Bureau attempted some studies of productivity trends. In 1926 the Bureau published its first indexes of output per man-hour for selected industries.[3] Later, as the depression of the 1930's resulted in mounting unemployment, the need to throw some light on this problem resulted in a national research project sponsored by the WPA, which collected and published a vast amount of detailed data on labor requirements and output. This was followed in 1940 by congressional legislation authorizing the Bureau to undertake continuing studies of labor requirements in American industries.

Shortly thereafter, in 1942, the interest in information on productivity trends in American industry resulted in publication of a detailed report on trends in output per man-hour and unit labor cost for selected industries and for total manufacturing, covering the period 1919 to 1939.[4]

During World War II, primary emphasis was on meeting labor requirements for firms engaged in war production, and a few special studies were made in this connection. In addition, the Bureau collected and published information on technological developments. However, much of the work on industry trends was suspended because of the difficulties in obtaining reliable data. After World War II, individual industry-trend studies were resumed.[5]

Thus, much of the Bureau's historical work in the field of productivity has been related to problems of labor requirements, labor displacement, labor cost, and technology. It is recognized that gains in productivity provide the means for increasing real earnings and leisure time, but do not automatically result in these benefits to society. They are achieved in an economic climate of full employment and continued growth in per capita consumption. The Employment Act of 1946 sets forth the objective of maximizing employment, production and purchasing power. Its implementation requires constant scrutiny of economic developments. Since productivity is a key element in the body of economic statistics needed for this purpose, it is important that information about its rate of change be available.

DESCRIPTION OF THE INDEXES[6]

GENERAL

Changes in the amount of labor time required to produce the output of the total manufacturing sector depend largely on changes in the average productivity of manufacturing establishments (and hence on the gradual adoption of improved manufacturing methods and developments in technology). But these changes also depend on shifts from year to year in the relative proportion of output produced in more efficient as compared with less efficient plants, and similarly on shifts in the relative importance of industries. An overall gain in output per man-hour can also be achieved by economies in the use of materials and purchased services.

In order to study the relative influence of these factors the Bureau has prepared for the manufacturing sector four series of indexes of change in output per man-hour (or the inverse man-hours per unit of output) covering the years 1947 and 1949 through 1953, and three sets of indexes for the year 1939 (data are not available for the fourth). Each has its special characteristics and limitations, which are in part conceptual, in part problems of available data. While each of the 4 series has a special restricted meaning, the usefulness of each is enhanced by the availability of the other 3. Moreover, because of the statistical problems of measurement, none is a precise measure, but the availability of the four measures and a comparison among them allows for some indirect evaluation of their reliability.

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[3] Indexes of Productivity of Labor in the Steel, Automobile, Shoe, and Paper Industries, Monthly Labor Review, July 1926, pp. 1–19.

[4] Productivity and Unit Labor Cost in Selected Manufacturing Industries, 1919–40, U. S. Department of Labor, Bureau of Labor Statistics, 1942. Industry measures were revisions and extensions of previous estimates of the national research project of WPA. The manufacturing index was based on the work of Solomon Fabricant of the National Bureau of Economic Research.

[5] Productivity Trends in Selected Industries—Indexes Through 1950, Bureau of Labor Statistics Bull. 1046, October 1951; and individual industry reports.

[6] See appendix I for more detailed description and mathematical formulas.

The primary distinction between the four sets of indexes is the way in which output is measured. Actually, they may be grouped into two general types. In one case productivity is measured in terms of physical output, with the relative importance of industries held constant; this reflects primarily the average change in productivity of plants and industries in manufacturing. In the other case, productivity is measured in terms of net output (or constant dollar value added); this index reflects not only the changes in the physical output type of index but it is also influenced by the shifts among industries and savings in materials consumption.

There are no conceptual differences between the series arising from the labor input side of the ratio. There are possible alternative measures of labor input, but no variants have been introduced—all indexes refer to man-hours worked by production and related workers.

The net output index is consistent with measures of private gross national product per man-hour, so far as the output side of the ratio is concerned. Both of them are affected by changes in product and industry "mix" and by changes in the value of materials used. However, the generally available indexes of gross national product per man-hour relate output to the man-hours of all employees, whereas the indexes in the current report (both net output and physical output) deal only with man-hours of production workers. Different trends in the proportion of production to nonproduction workers would of course yield different productivity indexes. (See p. 318.)

Sometimes the term "net national product" is used to describe a measure of the economy's output which excludes depreciation. However, "net output" for manufacturing, as used in this report, is consistent with "gross national product"—both of which include depreciation.

Net output may also be infererd to as value added by manufacturers. This, however, is not to be confused with certain other measures of production, such as those of the Federal Reserve Board, where quantities of output are combined with fixed value-added weights. As previously indicated, the Bureau's net output measure does not use a fixed-weight scheme.

The two types of productivity indexes—physical and net output—may be measured in more than one way. The Bureau has prepared two indexes for each type. For the physical output productivity measures, one index is prepared in accordance with the relative importance of products and industries in the current year, and the other index in accordance with the relative importance in the base year. For the net output type of index, the pattern of output is allowed to vary, but the data are combined in one index by the pattern of prices in the base year and in the other by the pattern of prices in each current year.

Thus, in addition to conceptual differences between physical output and net output indexes, the base year and current year weighted physical output productivity indexes may differ from each other if the relative importance of industries has changed; and the base year and current year priced net output productivity indexes may differ if the relationship between industry prices has also changed.[7]

The conceptual differences between the four sets of indexes may also be described as follows:

> *Physical output per man-hour; base year weighted.*—The change (from base year to current year) in output per man-hour, assuming that the proportions of goods produced by each industry in the base year are also produced in the current year.
>
> *Physical output per man-hour; current year weighted.*—The change in output per man-hour, assuming that the proportions of goods produced by each industry in the current year were also produced in the base year.
>
> *Net output per man-hour; base year prices.*—The change in output (value added) per man-hour accepting the change in proportions of goods produced by each industry, but assuming that the relative "price per unit of value added" in the base year is maintained in the current year.

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[7] See also discussions of individual industry measures and limitations.

Net output per man-hour; current year prices.—The change in output (value added) per man-hour, accepting the change in proportions of goods produced, but assuming that the relative "price per unit of value added" in the current year is also applicable to the base year.

In preparing these indexes, the Bureau developed separate estimates of output and of man-hours for the so-called four-digit industries[8] and then aggregated them to total manufacturing (differently, however, for the physical and net-output series). In many cases, different methods of aggregating are merely differences in worksheet technique and yield the same algebraic results. In some cases, however, when sampling is used, the process of aggregation also involves making estimates for missing components and these may be made in different ways under different basic assumptions.

The estimating procedure actually followed in the present study can be outlined most conveniently and the technical problems and shortcomings indicated most clearly by considering how output and man-hours worked are estimated in the case of the individual industry (the four-digit) groups, and how the data for individual industries are aggregated. The following pages describe (*a*) the preparation of man-hours indexes which are common to all the indexes, (*b*) the steps followed in preparing the physical output indexes, and (*c*) the steps followed in preparing the net output indexes.

MEASURING MAN-HOURS

The labor input series used in constructing the output per man-hour indexes refer to man-hours of production and related workers. The data exclude time of employees engaged in executive, administrative, technical, sales, and office activities, and force account workers.

Census statistics on man-hours are used for the 1947–53 indexes. For the 1939 indexes, the man-hour estimates are based on a combination of census and BLS employment and man-hour statistics for 1939 and 1947. The census data conceptually cover time worked or paid for, including hours for standby and similar types of time at the plant, paid for but not worked; they exclude hours on paid vacations, paid holidays and paid sick leave.[9]

The annual man-hour estimates for each industry include the total man-hours (of production workers) of each establishment classified in the industry during the year, regardless of the particular products being manufactured or of the differences in skill among individual workers.

PHYSICAL OUTPUT PER MAN-HOUR

Measuring output—industry level

For the physical-output series, indexes of output per man-hour (and the reciprocal unit man-hour requirements) are prepared at the four-digit industry level (or combinations thereof). In order to arrive at this index of ratios, indexes of production and of man-hours are prepared separately and then one is divided by the other.

Production indexes are prepared by use of basic-product data from the Bureau of the Census and other sources, using the greatest amount of detail available.[10] The number of physical units manufactured is specified as the basic unit of measurement, but this often leads to some problems. For example, should textile production be measured in linear yards, square yards, or pounds of the various types of cloth? The Bureau has tried—wherever there is a choice—to measure output in terms of the unit which is most closely related (i. e., proportional) to the unit man-hours spent in its production.

In order to add the different units of products, they must first be expressed on some common basis. This is done in the measures of physical output, where possible, by the use of man-hour weights—that is, the number of units of each product are multiplied by the unit man-hours required for its production in the base year. From time to time, as information becomes available, new products (not made in the base year) are introduced into the output measure.

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[8] Standard Industrial Classification Manual, Bureau of the Budget, November 1945.

[9] Although census questionnaires request that man-hours be reported in accordance with this definition, there has been no general, scientifically controlled followup survey to test the accuracy with which this definition is followed.

[10] It is usually desirable, in the preparation of output measures, to start with the most detailed level of product specification. In this present work, the Bureau has generally used published and unpublished information already compiled by other sources supplemented in some cases by data obtained especially for this purpose from individual plants. If resources were available, additional and finer detail could likely be obtained from more extensive plant surveys.

Although the mathematical form of the index requires the use of unit man-hour weights, most often this information is not available for individual products; other weights are substituted, sometimes unit labor cost or unit value added, but usually unit value. It is assumed that on the average, these weights are proportional to unit man-hour weights. (In some industries it is necessary to use information on consumption or dollar value of shipments because physical unit data are not available.) When the weighted units of output are added the result is a measure of output for the industry.

The output of a given industry is often composed of many products—some of which are considered primary to the industry and others which are considered as secondary. Some of the primary products may be made in both the given industry and other industries. The production measures just described are usually based on the trend of output of primary products, wherever made, assuming that, on the average, this represents the trend in quantity of primary and secondary products produced in the industry. In some cases, data for four-digit industries are combined in order to avoid this problem. For the period 1939–47, special adjustments were made in a number of industries. (See appendixes I and II.)

After the units of production are added for each year the total is converted to index form, using 1947 as the base date. The production index thus derived for each industry for each year is called a base year weighted index (products weighted by man-hours, value or other measure of relative importance).

Measuring output per man-hour —industry level

Each industry production index is divided by the industry index of man-hours to derive an index of output per man-hour index; conversely, dividing man-hours by output yields man-hours per unit of output. The resultant productivity indexes are "current year composite" indexes. They measure the change in the number of man-hours required to produce each current year's composite of goods, from the number that would have been required in the base year to produce that same total of output.

It may be noted that a base year weighted production index, when divided by a man-hour index, yields a current year composite output per man-hour index. (See mathematical formula in appendix I.)

These industry productivity indexes serve as the basis for both variants of the all manufacturing physical output productivity indexes.

Aggregation to total manufacturing

In constructing the indexes of output per man-hour (or man-hours per unit of output) for manufacturing the 4-digit industry (or combination) productivity indexes are aggregated through the 3- and 2-digit industry levels. It is important to note at this point that physical-output indexes cover a sample of industries—about 200 out of some 460 4-digit industries, which account for over 70 percent of employment in all industries. Therefore, it is necessary to make estimates, or imputations, for the missing components.

The steps of aggregation are as follows: (*a*) The productivity indexes for the covered 4-digit industries are combined by use of industry man-hour weights to arrive at a 3-digit industry index; it is assumed that the producivity trend for the noncovered 4-digit industries is the same as the trend for the sample industries. (*b*) The estimated productivity indexes for each 3-digit industry are then combined, with man-hour weights, to yield a 2-digit industry group index, assuming that productivity of the noncovered 3-digit industries moves like that of the covered industries. (*c*) The 2-digit industry groups are combined with man-hour weights to total manufacturing; here all industries except ordnance are covered and no imputations are made.

Two systems of man-hour weights are used for combining the 4-, 3-, and 2-digit industry productivity indexes: In one, the weight is the total production worker man-hours in the industry (4-, 3-, or 2-digit, respectively) in the current year. This manufacturing index shows the change from the base year to the current year, in labor time required to produce the current years composite of product and industries. In the other, industry man-hours in the base year are used as weights. This index shows the change between the base and current year in labor time required to produce the base year composite (this is an approximation, because the 4-digit industry indexes on which it is based are computed with current rather than base year quantity weights).

Each of these physical output productivity series—referred to as base-year and current-year weighted—is an average of the productivity changes for its component industries. Neither, by itself, is affected directly by changes in the relative importance of products or industries, since these are held fixed for both the base-year and current-year estimates.

NET OUTPUT (OR DOLLAR VALUE ADDED) PER MAN-HOUR

Measuring output—industry level

It is possible to construct an output index by equating commodities as dissimilar as tanks and women's hats, on the basis of constant-dollar value added. Value added is the difference between value of gross output and costs of inputs of materials, supplies, containers, fuels, purchased electric energy, and contract work. Thus, if the amount of materials required for processing is reduced, and the value of gross output remains the same, the value added by the industry increases. If the value added (also called net output) of every industry were aggregated, in dollars, we would have a gross national product type of output measure, equivalent to the value of all sales to final purchasers.

The census definition of value added (adjusted for inventory change) is used because of the availability of census data in substantial industry detail. Conceptually there would be some advantage if the definition used in national income statistics could have been used.[11]

Net output (value added) increments contributed at each level of production, or each industry, provide a convenient unit of measurement and avoid some of the difficulties of adding physical units of different commodities. This solution, however, has its own problems since the prices of commodities do not remain constant. The dollar figures used in this form of measurement must be adjusted for such price change, otherwise spurious changes in productivity could result.

Thus, one of the basic problems encountered in this task is the deflation of value so that output can be measured in constant dollar terms. For this the BLS is fortunate in having a large body of relevant data developed in its wholesale price and its interindustry (input-output) research programs. Information from these sources has been combined to construct price indexes for industry output and materials inputs. This has made it feasible for the Bureau to develop, for the first time, net output measures and, in turn, indexes of net output per man-hour (and man-hours per unit of net output) for the manufacturing sector.

Appropriate price indexes for directly deflating value added are not available; however, data are available for constructing price indexes which can be used to deflate the cost of materials and the value of final output, so these are deflated separately; the difference between the two is the deflated value added.

The price indexes used for deflators are derived from the detailed indexes of wholesale prices, recombined into industry groupings. The industry price index is based only on prices of selected products (i. e., in the wholesale price index sample) which are primary to the industry; this assumes that the price movement of secondary products is similar to that of the primary products. The industry price indexes thus constructed are used to deflate the value of gross (final) output of each of their respective industries.

In order to deflate the value of materials purchased by a given industry, price indexes for those industries from which it makes purchases, are combined in accordance with the relative 1947 purchases by the given industry from the supplying industry (i. e., with 1947 weights).

The industry price indexes thus derived for each year from 1949 to 1953 represent the changes in prices for a base year (1947) composite of goods. The value of output and cost of materials in 1947 are multiplied by each of the successive price indexes to yield values in current-year prices. For example, 1947 gross value of output times the 1952 price index equals 1947 gross value of output stated in 1952 prices. The difference between deflated (or, in this case, inflated) gross output and material is deflated value added. The value added in 1952 is obviously already stated in 1952 prices.

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[11] The cost of certain business services such as insurance, advertising, and communications are excluded, and excise taxes included in the gross national products accounts. There is a difference between the census and BLS estimates of value added, arising out of the relationship between shipments, inventories, and production. The BLS has adjusted the Census shipments data to include the value of net change in finished goods and goods-in-process inventories, to yield a production estimate. Published census figures of value added do not make this adjustment.

Thus, we have 1947 net output stated in 1949 prices, 1950 prices, and so on, and a comparable series of net output for each of the years 1949–53), stated in their own current-year prices. These are used to derive one type of the net output per man-hour indexes.

Another set of estimates of net output has been for each of the years 1947 and 1949–53, expressed in base year (1947) prices. This is done by dividing the current-year values by the price indexes (previously described) for that year. However, this is an approximation of base-year prices. The appropriate price index for converting the values of each current year into base-year prices would be one constructed by use of current-year quantity weights—but such indexes are not available.

Aggregation to total manufacturing[12]

Unlike the physical output series, where a sample of industries is used, the net output series for manufacturing are based on data for all of the four-digit industries (with a few very minor exceptions) so no imputation is necessary.

The estimates of value added in current-year prices, prepared for each four-digit industry (or combination), are added directly to give a manufacturing total in current-year prices.

The approximations of value added in base-year prices, prepared for each of the four-digit industries (or combination), are also added to yield a manufacturing total in base-year prices (approximately).

The total value-added estimates are converted to index form and paired with indexes of man-hours in manufacturing to yield two sets of productivity indexes—net output (or value added) in base-year prices (approximation) and net output in current-year prices.

SUMMARY OF STATISTICAL LIMITATIONS

Limitations of available data and resources for measurement, make it impossible to construct absolutely precise indexes of productivity. Such indexes are indicators of productivity trend and, are more reliable for a period of years than for single years. As such they are useful in studying the economy and its growth, in evaluating the technological progress of industry, and in understanding the employment implications of the changing relationship between output and manpower requirements. They should not be regarded as precision instruments.

Some of the problems of measurement are discussed in the preceding section of methods; these problems and others also are described in the technical appendix to this report. However, it is worth summarizing some of them here.

Physical and net output indexes

Existing data and techniques do not provide for a full accounting of the continuing changes in the quality of goods produced. To a limited extent, identifiable changes in product specification are taken into account in the Bureau's indexes. In many cases, however, specification and quality change are not reported; in other instances, quality change is so intangible that it cannot be measured with existent techniques. Since quality on the average is improving, indexes of productivity generally understate the gains which occur over time.[13] This understatement occurs generally in individual industries as well as in broader groupings, such as total manufacturing, and affects all the manufacturing productivity indexes prepared by the Bureau. It should be noted that this problem of quality change characterizes all existent production measures and many other statistics as well.

Physical output indexes

(*a*) Changes in the degree of plant integration and specialization are often not adequately reflected in the production statistics. This may result in overstatement of productivity gains in some industries, understatement in others.

(*b*) All the man-hours of an establishment are assigned to an industry in accordance with major production.[14] On the other hand, available data on physical output are based on total primary production, regardless of the industrial classification of the establishments manufacturing a product. When

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[12] Industry productivity indexes for the net output series were computed but not for purposes of arriving at an all-manufacturing index. Such indexes were calculated only for purposes of internal examination, analysis, and evaluation of final results.

[13] In exceptional periods such as wartime an opposite bias probably occurs.

[14] Establishments are classified on the basis of their major activity in accordance with the Standard Industrial Classification Manual, Bureau of the Budget, November 1945.

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changes in output result in a change in the industrial classification of an establishment, or when there are changes in the proportion of products made within and outside the primary industry, the comparability of production and man-hour trends for an industry may be impaired.

(*c*) Unit man-hour weights, desired for combining quantities of products in the construction of industry measures, are not currently available for a majority of individual commodities (although man-hour weights are available for combining industries). Other weights, usually unit value, have been substituted. Also, in some industries, quantity data are not available, and information on consumption (of materials) or on deflated value of shipments is used. The use of these kinds of value data at the product level can cause the resultant productivity indexes to be influenced by the change (between time periods) in the proportion of products made in the industry.

(*d*) Because of lack of data for weighting purposes, it has been necessary to use 1 basic set of indexes at the 4-digit industry level for both types of physical-output indexes constructed by the Bureau. In combining the 4-digit indexes, however, 2 different weighting schemes are available and are utilized.

(*e*) The estimates of output per man-hour for groups and for all manufacturing are based on a sample of industries covering approximately 200 of about 460 4-digit SIC industries, which represent over 70 percent of employment in all industries. To the extent that the change in output per man-hour in the covered industries does not adequately represent the industries not included, the estimate for total manufacturing may be in error.

Net output indexes

(*a*) Estimates of shipments, cost of materials, inventory change, and man-hours obtained from the Annual Survey of Manufactures are based on a sample of establishments and are therefore subject to sampling errors.

(*b*) Most of the limitations of the net-output measures stem from limitations of the price indexes used for deflation. Some of the factors which may affect the reliability of the price indexes are:

(1) The number of products covered varies among industries, and is quite low in some of them.

(2) It has been necessary to assume that the price trends of secondary products of an industry are the same as the price trends of the primary products.

(3) Two types of price indexes are required for deflation at the 4-digit level, i. e., with 2 weighting schemes. However, only one is available, resulting in an approximation of the net output index in base-year prices.

Conclusions

For the most part the limitations described may be of some significance for the indexes of individual industries, but are not considered to be of major importance for broader aggregates such as total durable and nondurable goods, and even less so for total manufacturing. Although their significance is very difficult to check empirically, because the very data needed to make the correct adjustments to the basic data in the first instance are needed for testing the extent of the error, there is no reason to believe that the errors are primarily in one direction leading to an upward or downward bias. The errors due to sampling, plant integration versus specialization, problems of primary and secondary production, and substitution of unit value weights for unit man-hour weights may overstate gains in some industries but will also understate them in others, so that errors in opposite directions tend to offset each other.

Many of the deficiencies may be remedied as basic data are expanded or improved over time or as special studies of individual industries can be undertaken. Moreover, the Bureau has made special adjustments for many industries by obtaining additional data, combining industries, and rejecting industry data in certain instances where coverage is too small for purposes of the manufacturing indexes. To the extent that its resources and data permit, the Bureau will continue to make improvements in its estimates of changes in output per man-hour.

Finally, some testing of the assumptions has been made, not always directly because appropriate data are not available. These tests indicate in a general way that the various assumptions and substitutions made in the course of work on the individual industries have not led to any significant bias in the measures for total manufacturing, or broad groups such as durables and nondurables. Some of the special work and tests the Bureau has undertaken are described in the following section.

TESTS AND STANDARDS

In a work of this magnitude in which data are drawn from a variety of sources, the question arises, "What is known of the possible errors or biases and can any tests be devised to provide some assurance that the calculated trends are reasonably accurate?" Direct proof cannot be developed from the existing data, Nevertheless, a number of observations, tests, and comparisons have been applied to these series and are summarized here. A more detailed description appears in appendix II, Description of Tests and Standards.

Comparison with related series

In addition to the 4 indexes published in this report, 5 other indexes were computed for purposes of comparison. They include 2 indexes based on deflated value of shipment, 1 based on deflated value of primary product, 1 based on the Federal Reserve Board Index of Production, and 1 based on deflated value of Office of Business Economics' estimates of manufacturers' sales and inventories. Although there is some variation in year-to-year changes, the 5 specially computed indexes are quite close to the published indexes in 1952, ranging from 117 to 121, with the lowest 1 most comparable to the lower of the published indexes.

Thus, there is strong evidence that any errors or biases which exist in the measures for individual industries do not result in a systematic error for all industries and that no significant bias exists in any of the four published manufacturing indexes.

Coverage of the production indexes

The BLS adopted certain standards of coverage for individual industries. If any industry fell below these standards, the data were rejected. In order to be acceptable, an industry index component, for example, must be based on data for at least 50 percent of the industry's output in terms of 1947 value. In only 8 industries of 79 in which quantity data are used is coverage as low as 60 percent and in 38 it is 80 percent or higher. This standard of acceptance is somewhat more severe than that used by many others.

Product coverage change (primary-secondary)

Specific actions taken with respect to the problem of primary-secondary production include the following:

(1) *Combination of industries.*—In a number of cases where overlapping of products between 4-digit industries could be determined, the 4-digit industries were combined. This is one of the principal reasons why the 198 4-digit SIC industries covered directly in the manufacturing index are represented by only 152 separate indexes.

(2) *Coverage requirement.*—Industries in which primary products made within the industry would constitute a very small proportion of total value of output (of the industry) would be eliminated under standards for coverage.

(3) *Adjustment, 1939–1947.*—As indicated earlier, the Bureau has made adjustments in selected industries to correct for changing coverage for the period 1939–47. Adjustment factors are derived from 1939 and 1947 ratios of value of items in the index to total value of the industry's products. The effect of coverage adjustment at the total manufacturing level was very small. Actually, minimum and maximum production indexes constructed for total manufacturing for 1939, based on selection of minimum and maximum components before and after adjustment, range from 58.5 to 60.3.

Unit man-hour weights

Exhaustive tests of the proportionality of unit man-hours and unit values (for weighting purposes) have not been possible although the Bureau has made some investigation of the problem. Also, studies of the WPA national research project in the late 1930's indicate that, in the industries which they studied, use of unit-value weights generally would not yield results significantly different from those obtained with unit man-hour weights.

These tests are described in greater detail in Appendix II, Description of Tests and Standards. They indicate that a significant error has probably not been introduced into the manufacturing indexes as a result of this type of substitution.

TRENDS IN OUTPUT PER MAN-HOUR AND MAN-HOURS PER UNIT OF OUTPUT

PRIOR TO 1939

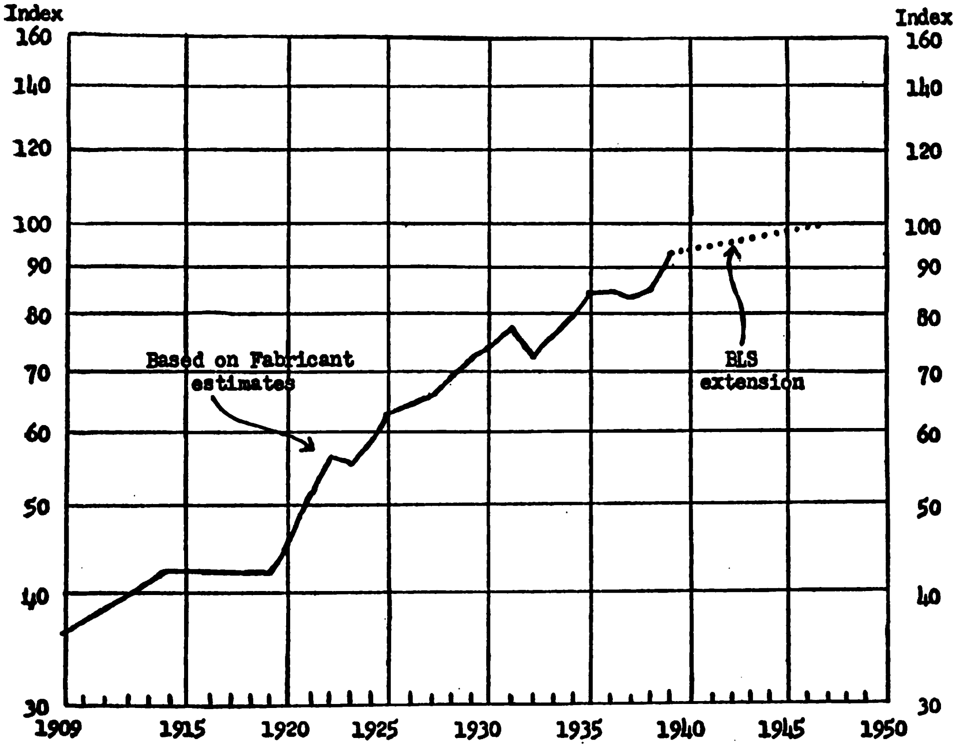
Although the Bureau's current effort was directed toward preparation of indexes covering the period 1939, 1947, and 1949–1953, it is helpful to summarize past trends for historical perspective and evaluation of current rates of change. It should be noted, however, that indexes for manufacturing for the period 1909-39 were prepared in a somewhat different conceptual framework and are therefore not strictly comparable with those of our current series.[15]

According to these earlier estimates,[16] output per man-hour increased at an average rate of 3.3 percent per year from 1909 to 1939 (table 1). During this 30-year period, declines apparently occurred in only 3 years—1923, 1932, and 1937. From 1914 to 1919 there was no change in output per man-hour, reflecting the industrial dislocations of World War I.

After World War I there was a rapid spurt in output per man-hour, followed by a 1-year drop (1923) and then a more moderate, but still fairly sizable rate of increase for several years. It is interesting to note that an average rate of over 2 percent per year was maintained during the decade 1929–39, characterized by many years of depression.

CHART A. OUTPUT PER MAN-HOUR, ALL MANUFACTURING 1909–47

1947=100



The production index from which output per man-hour is derived for 1909, 1914, and the odd-numbered years 1919–39 is from Employment in Manufacturing, 1899–1939, by Solomon Fabricant (National Bureau of Economic Research). The index for the years 1920–38 was completed by interpolation, using the Federal Reserve Index for Manufactures. For 1947, the index is based on the production index (cross-weighted and adjusted for coverage) published by the Federal Reserve Board and the Bureau of the Census in Indexes of Production, 1952: The index of man-hours was derived from an employment index, based on Census and BLS figures and a series for average weekly hours including BLS figures for 1909, 1914, 1919, 1923–39, and 1947 and estimates for 1920–22 based on BLS data for average weekly earnings and data for average hourly earnings as shown in Employment, Hours and Earnings in Prosperity and Depression, United States, 1920–22, by W. I. King.

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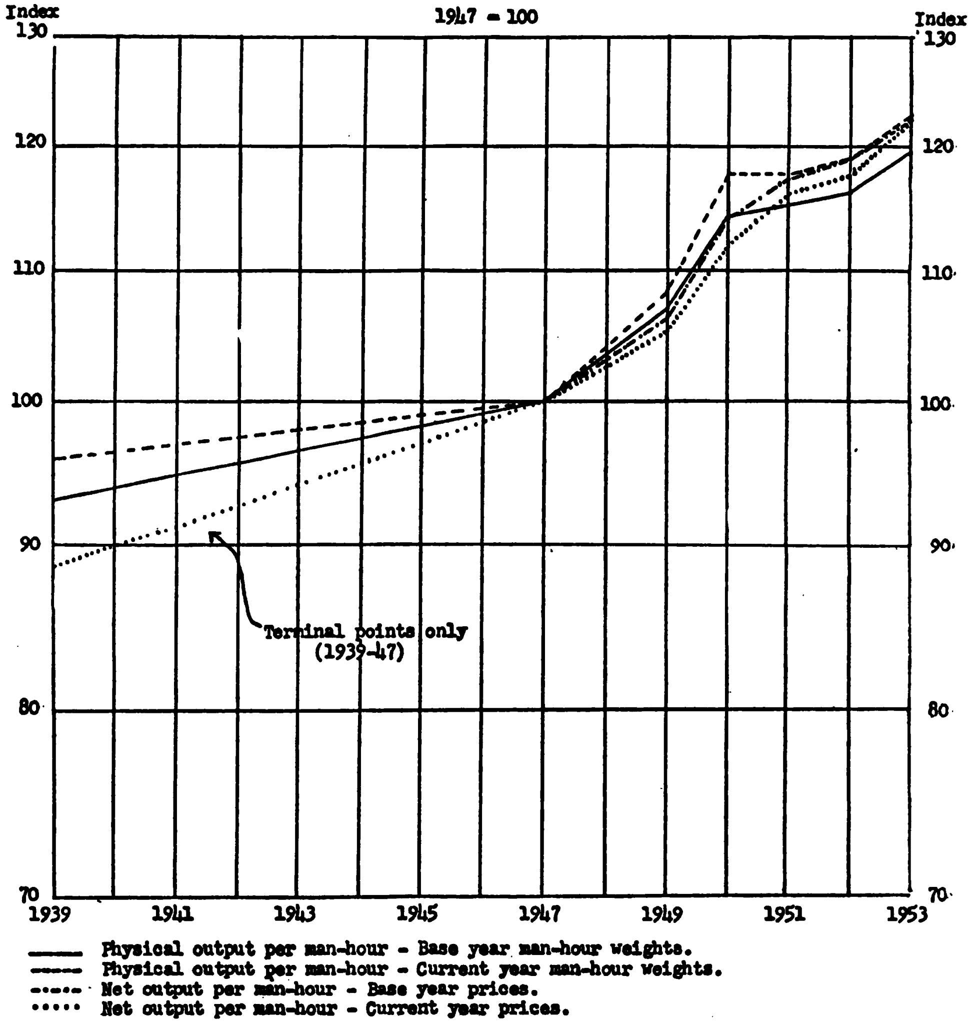
[15] Weights used for 1909–39 are value added, averaged for base year and current year (i. e., cross-weighted. Reference, Productivity and Unit Labor Cost in Selected Manufacturing Industries). For 1939–53, weights are either current or base year man-hours (between industries) for physical output series, and current or base year prices for net output series.

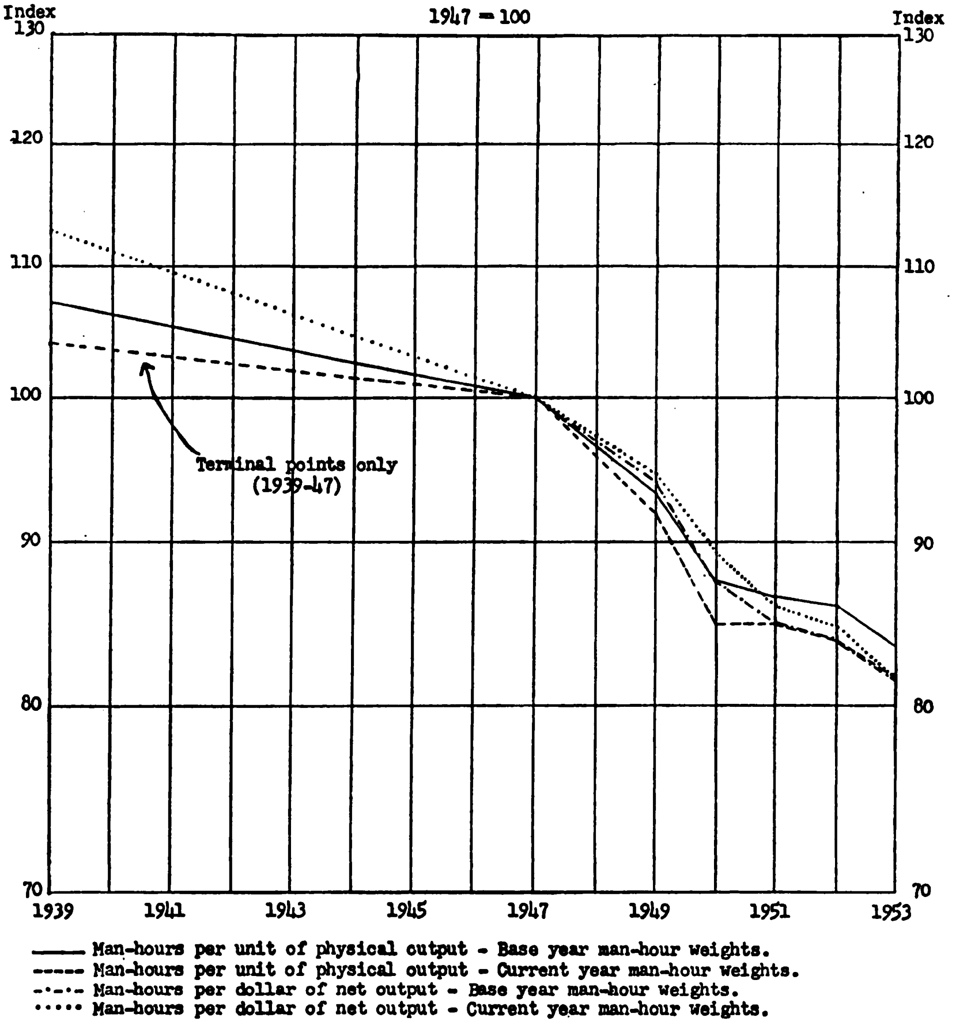
[16] Trends in output per man-hour in all manufacturing between 1909 and 1939 are published in the Handbook of Labor Statistics, 1950 edition, Bulletin No. 1016, U. S. Department of Labor, Bureau of Labor Statistics.

CHART B. OUTPUT PER MAN-HOUR, ALL MANUFACTURING 1939–53



Note: Data not available for 1940 through 1946 or for 1948.

CHART C. MAN-HOURS PER UNIT OF OUTPUT, ALL MANUFACTURING 1939–53



Note: Data not available for 1940 through 1946 or for 1948.

TABLE 1.—*Average annual percent change in output per man-hour, manufacturing, selected periods, 1909–39*

Period	Percent change [1]	Period	Percent change [1]
1909–39	+3.3	1914–19	([2])
1909–19	+1.4	1919–29	+5.3
1909–14	+2.9	1929–39	+2.2

[1] Computed from the least squares trend of the logarithms of the index numbers. For the period 1909–14 and 1914–19 terminal points only are used since data for intervening years are not available.

[2] No change.

TABLE 2.—*Average annual percent change in output per man-hour and man-hours per unit of output, manufacturing by type of index, 1939–47 and 1947–53*

Type of productivity index	Type of "weight" used in production indexes [1]	Average annual percent change [2]			
		In output per man-hour		In man-hours per unit of output	
		1939–47	1947–53	1939–47	1947–53
Physical output:					
Current year composite	Base year man-hours	+0.5	+3.4	−0.5	−3.3
Base year composite [1]	Current year man-hours	+.9	+3.0	−.9	−2.9
Net output:					
Current year prices	Current year prices	+1.5	+3.5	−1.5	−3.4
Base year prices [1]	Base year prices	([3])	+3.6	([3])	−3.5

[1] Except for substitution at the product level; see text and technical note.

[2] For 1939 to 1947 based on indexes for 1939 and 1947 only; indexes for intervening years are not available. Average increase for 1947 to 1953 computed from the least squares trend of the logarithms of the indexes (similar to compound interest formula).

[3] Information not available.

TABLE 3.—*Change in production, physical output per man-hour and unit man-hours, manufacturing, durables and nondurables, 1939–47, 1947–53*

Type of industry	Current year weighted [1]			Base year weighted [1]		
	Production	Output per man-hour	Unit man-hours	Production	Output per man-hour	Unit man-hours
	Percent change, 1947–53					
Total manufacturing	+33.2	+22.7	−18.5	+29.9	+19.6	−16.4
Nondurable goods industries	+19.3	+20.1	−16.8	+17.5	+18.3	−15.5
Durable goods industries	+44.4	+24.5	−19.7	+40.0	+20.7	−17.1
	Percent change, 1939–47					
Total manufacturing	+68.4	+4.2	−4.0	+73.3	+7.3	−6.8
Nondurable goods industries	+40.1	+1.2	−1.3	+41.4	+2.2	−2.2
Durable goods industries	+101.2	+7.6	−7.1	+107.5	+11.0	−9.9

[1] The terms "current year weighted" and "base year weighted" refer to the man-hour weighting systems used to combine the industry output per man-hour indexes. For fuller discussion see text and technical notes.

TABLE 4.—*Indexes of physical output per man-hour, unit man-hours, production, and man-hours, manufacturing, durable- and nondurable-goods industries, 1939 and 1947–53*

[1947=100]

Year	Current-year weights [1]				Base-year weights [2]			
	Output per man-hour	Unit man-hours	Production	Man-hours	Output per man-hour	Unit man-hours	Production	Man-hours
	Total manufacturing							
1939	96.0	104.2	59.4	61.9	93.2	107.3	57.7	61.9
1947	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1949	108.6	92.0	96.8	89.1	107.2	93.3	95.5	89.1
1950	117.7	85.0	114.4	97.2	114.3	87.5	111.1	97.2
1951	117.5	85.1	121.0	103.0	115.2	86.8	118.7	103.0
1952	119.1	84.0	123.1	103.4	116.3	86.0	120.3	103.4
1953	122.7	81.5	133.2	108.6	119.6	83.6	129.9	108.6
	Non-durable-goods industries							
1939	98.8	101.3	71.4	72.3	97.8	102.3	70.7	72.3
1949	105.9	94.4	100.3	94.7	105.4	94.9	99.8	94.7
1950	112.5	88.9	110.8	98.5	111.5	89.7	109.8	98.5
1951	114.7	87.2	112.1	97.7	113.2	88.3	110.6	97.7
1952	116.9	85.5	113.9	97.4	115.4	86.7	112.4	97.4
1953	120.1	83.2	119.3	99.3	118.3	84.5	117.5	99.3
	Durable-goods industries							
1939	92.9	107.6	49.7	53.5	90.1	111.0	48.2	53.5
1949	111.0	90.1	94.0	84.7	108.5	92.2	91.9	84.7
1950	122.0	82.0	117.2	96.1	116.8	85.7	112.2	96.1
1951	119.6	83.6	128.2	107.2	117.0	85.5	125.4	107.2
1952	120.6	82.9	130.5	108.2	117.2	85.3	126.8	108.2
1953	124.5	80.3	144.4	116.0	120.7	82.9	140.0	116.0

[1] Industry output per man-hour indexes combined with current-year weights; equivalent to industry-production indexes combined with base-year weights.

[2] Industry output per man-hour indexes combined with base-year weights; equivalent to industry-production indexes combined with current-year weights.

TABLE 5.—*Indexes of net output*[1] *per man-hour, unit man-hours, production, and man-hours, manufacturing, 1939 and 1947–53*

[1947=100]

Year	Base-year prices				Current-year prices			
	Net output per man-hour	Man-hours per dollar of net output	Net output	Man-hours [2]	Net output per man-hour	Man-hours per dollar of net output	Net output	Man-hours [2]
1939	(³)	(³)	(³)	(³)	88.7	112.8	54.9	61.9
1947	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1949	106.3	94.1	94.8	89.2	105.5	94.8	94.1	89.2
1950	114.1	87.6	110.9	97.2	111.9	89.3	108.8	97.2
1951	117.3	85.2	121.2	103.3	116.2	86.1	120.0	103.3
1952	119.1	84.0	124.8	104.8	117.7	84.9	123.4	104.8
1953	122.5	81.6	135.6	110.7	122.4	81.7	135.5	110.7

[1] Value added at constant prices.

[2] Dissimilarity of man-hour indexes for the physical output and net output series is due to some differences in industry inclusion.

[3] Information not available.

TRENDS FROM 1939 TO 1947

The Bureau has prepared 3 sets of indexes for the period 1939 to 1947; 2 physical output and 1 net output measure. Average annual changes for this period are shown in table 2.

Although the detailed picture of productivity change from 1939 to 1947 is obscured because of the lack of statistical data for intervening years, it is clear that the average rate of productivity growth in manufacturing was considerably dampened by the events of World War II. This period was marked by unprecedented economic expansion for military needs in some industries and dislocations in other industries producing less essential goods.

The rather low rate of increase in output per man-hour, ranging from 0.5 to 1.5 percent, for the 1939–47 period, compared with the lack of increase in the World War I period, 1914–19, indicates the depressing effect (on productivity) of major interruptions to industrial activity and the subsequent reconversion to peacetime production.

Another point of some interest in interpreting the trend in output per man-hour during this period is the significant difference between the average rates of change for the three measures. For the base year composite physical output index the rate was 0.9 percent, a low rate of increase but still almost twice as much as the 0.5 rate of increase for the current year composite physical output measure. Industries (2-digit) with a higher than average increase in production had a greater than average increase in output per man-hour. Thus, the faster growing industries (1939–47) are given higher relative weight for the base year composite index than for the current year composite.[17]

In addition, the industries (2-digit) with a greater than average increase in production also had higher than average value added per man-hour. The physical output indexes are not affected by the shift from low to high value-added per man-hour industries whereas the net output index is affected by such shifts. The latter measure with a 1.5 percent annual rate of increase was significantly higher than the corresponding physical output index.

An analysis of the major groups (2-digit industries) within total manufacturing indicates that most of the increase in both production and output per man-hour occurred in the durable goods industries, with the nondurable industries showing on the average almost no gain in output per man-hour during this period.

TRENDS FROM 1947 TO 1953

The indexes for 1947–53 cover a 6-year period marked, with but brief interruption, by general economic growth. The postwar boom of 1947 and 1948 was followed by the recession of 1949, and then recovery in 1950. Expansion of the civilian economy in 1951 and 1952 was complicated by Korean defense mobilization. The early part of 1953 saw a continued expansion but this was interrupted by a business downturn in the latter half of the year.

The 4 measures show average annual rates of increase for the period 1947 to 1953 ranging from 3.0 to 3.6 percent (table 2). This range is in line with the long-run increase from 1909 to 1939 which is about 3.3 percent. The estimate for the long-run period was based on a measure which in concept differs from those presented in this report, and in addition has a lower proportion of direct industry coverage than the current set of measures. It is felt, however, that the differences are not sufficiently great to invalidate the general comparisons.

Comparison with the experience of the past can be further illuminated by contrasting the post-World War II period with the more directly comparable period after World War I. The average annual increase in output per man-hour during the decade 1919 to 1929 was about 5.3 percent. This comparison must be qualified, however, by the fact that the increase during the earlier period was affected significantly by the shift from low to high value-added-per-man-hour industries. If an adjustment is made for this shift, the average change

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[17] This may be explained as follows:

PRODUCTIVITY INDEX	BASED ON PRODUCTION INDEX WITH
Base year composite.	Current year (1939) man-hour weights.
Current year composit.	Base year (1947) man-hour weights.

Industries with higher than average production increase also had higher than average decline in unit man-hours (reciprocal of output per man-hour). Weights used in production index for these industries would be lower in base year (1947) than in "current" year (1939).

would be reduced to about 4.5 percent, thus yielding a range of 4.5 to 5.3 percent.[18]

Taking just the 6 years from 1919 to 1925 (comparable in timing to the 6 years 1947–53) the increase in manufacturing output per man-hour was close to 7 percent. Estimates of the effect of industry shift during this period are not available (from Fabricant's publication), but it was, undoubtedly, at least as important, relatively, as for the decade as a whole.[19]

It seems reasonable to infer from the above estimates that the average increase in manufacturing output per man-hour after World War II was substantially less than that which occurred in a comparable time period after World War I. Nevertheless, it represents a substantial gain over the low rate of increase of the 1939–47 period and is in line with the long-run average.

The problems of isolating the factors behind these differences, with particular reference to the role of technological change in the current period compared with post-World War I, will require further investigation. In this connection, the Bureau has initiated a program to collect and evaluate data, from both published sources and case studies, on recent technological innovations which may have a significant influence on the trend in output per man-hour.

Examination of the annual trends in output per man-hour for each of the four measures given in this report indicates some variation both in the year-to-year changes and among the indexes themselves. It is clear, however, that the year 1950 shows an unusually large increase for all four measures, about double the average annual increase for the 1947–53 period. This sharp rise in output per man-hour occurred during the period of revival and expansion following the recession of 1949, and, in fact, was accompanied by the largest annual increase in production for any of the postwar years, 1947 to 1953. This is of some special interest since it may imply that more than average gains in output per man-hour are to be expected during a period of recovery from low business activity, such as that experienced in 1954–55.

For the period as a whole, the relatively small differences between the indexes, as contrasted with the differences for the 1939–47 period, indicates that: (1) the increase in output per man-hour was affected to only a small degree by the shihfts between high and low value added per man-hour industries (comparison of physical with net output indexes), and (2) industries with greater than average increases in output per man-hour also had greater than average increases in production (comparison of two physical output series) although this was not as significant as in the 1939–47 period.

Finally, an analysis of the major components of the physical output measures for total manufacturing indicates that, although the durable goods industries showed a much greater than average increase in output, similar to that for the 1939–47 period, the increase in output per man-hour was but little higher than that of the nondurable goods industries. Further analysis of the differences between the two major groups of industries would require a more detailed study of the industry components within each of the major groups.

INDUSTRY VARIATION

The change in output per man-hour for manufacturing is an average of many component industries and does not necessarily represent the trend for any single industry.

Estimates for individual industries may be subject to a considerable margin of error because of certain deficiencies in available data. For this reason, estimates of individual industries need a great deal more testing and investigation, and are not now being published.

Despite the limitations, the industry estimates are useful for indicating the potential range of change in output per man-hour—or man-hours per unit of output—among the industries which form the components of the manufacturing sector. The 152 physical output per man-hour indexes indicate a considerable variation in trend.[20]

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[18] Based on information given in Fabricant's Employment in Manufacturing, National Bureau of Economic Research, New York, 1942, p. 335. A further qualification of the 4.5 estimate is to be found in the report on output per man-hour by the national research project which provided 2 measures of physical output per man-hour. Since the physical output per man-hour measure is not affected by the shift between industries, it provides a rough check on the adjusted estimate of 4.5 percent previously indicated. The base year (1929) and current year (1919) man-hour weighted measures of the national research project show increases of about 4.6 and 3.7 percent, respectively, for the 1919–29 period.

[19] National Research Project, base and current year weighted estimates show average increase of 5.8 and 4.8 percent, respectively, for the 1919–25 period.

Approximately one-half of the group had annual rates of increase of between 1 and 5 percent. A little over one-fourth ranged from gains of less than 1 percent to losses of more than 3 percent per year. The remaining industries (less than one-fourth of the total) show gains of 5 percent or more; in a few of these the increases were more than 10 percent a year.

TRENDS IN ALL EMPLOYEES AND PRODUCTION WORKERS

The man-hour component of the productivity series refers only to the time worked by production and related workers, exclusive of administrative, supervisory, technical, clerical, sales, and other nonproduction workers. Although this index is useful in estimating labor requirements, it is generally recognized that indexes based on man-hours of all employees would also be of economic significance.

Although man-hours for nonproduction workers are not generally available, a rough approximation of the extent of differences between "all employees" and "production workers" may be obtained from a comparison of trends in number of workers employed, without regard to changes in the length of the workweek. In evaluating these trends, it is important to note that production worker employment tends to be more sensitive to business fluctuations, declining and rising more sharply than the nonproduction group in periods of recession and recovery.

The number of nonproduction employees in manufacturing increased from 2.7 million to 3.6 million, a rise of 32 percent from 1947 to 1953 (census).[21] Production workers recorded only a 5-percent gain over this period. Thus, the increase in number of all employees was greater than for production workers alone. Indexes of output per employee (in 1953) would be about 4 percent lower than indexes of output per production worker. However, between 1939 and 1947 the difference in trend between all employees and production workers was negligible.[22]

PRIVATE GROSS NATIONAL PRODUCT PER MAN-HOUR

A recent report of the Joint Committee on the Economic Report[23] provides a good example of the application of a productivity ratio to problems of employment and economic growth.

One objective of the joint committee study was to estimate required private nonagricultural output for 1965, consistent with certain assumption of employment and unemployment levels. In order to carry out this estimate, projections of future productivity trends had to be considered. Assumptions concerning the extension of past trends, technological developments, and shifts between sectors are implicit in making projections of future productivity trends. The trend (from 1953 to 1965) assumed by the Joint Committee staff was 2.5 percent per year, lying between the long-term average 2.0 percent per year and the postwar average of about 3.5 percent for private nonfarm output per man-hour.

If sufficient data were available, a more detailed projection—with separate treatment of each of the sectors—would be useful and perhaps necessary for more precise evaluation of future growth. In this connection, measures for the manufacturing sector, and other sectors as they can be made available will contribute to this kind of study. There are some definitional differences between the estimates of private gross national product per man-hour prepared by the staff of the committee and the indexes of manufacturing productivity covered in this report.

The man-hours in the joint committee data are estimates of man-hours for all persons at work (including proprietors and unpaid family workers) and are therefore more inclusive than those used by BLS, which refer only to man-hours of production and related workers. Consequently, the BLS and joint committee estimates are not comparable, unless allowance is made for the difference in man-hour definition.

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[20] Based on analysis for period 1947 to 1952.

[21] Logging, central administrative offices and auxiliary units were not covered in the 1947 Census of Manufactures, but are included in the Annual Surveys of Manufactures for 1949 and subsequent years. However, published estimates of 1947 employment have been adjusted to include employment in these areas. In addition, estimates of 1947 employment in sawmills were adjusted to take account of under coverage.

[22] Similar results are obtained if trends for all employees and production workers are based on BLS employment data.

[23] Potential Economic Growth of the United States During the Next Decade, Joint Committee on the Economic Report, prepared by committee staff, Washington 1954. The data represent revisions of estimates of John W. Kendrick in his paper, National Productivity and Its Long-Term Projection, Conference on Research in Income and Wealth, May 1951. These revisions reflect: (1) Use of later data from the Departments of Commerce and Agriculture; and (2) a shift from 1939 to 1953 prices.

Also the man-hours used in the agricultural component are estimates of expected man-hours projected from benchmark data on man-hours per acre of crop, or per head or unit of production, with adjustments for selected factors such as yield per acre, source of power, production per animal, etc. Moreover, the hours are expressed in "man equivalent hours," that is, the time used by average adult male workers in performing farm jobs.

The output part of the joint committee's productivity ratio is similar in concept to the Bureau's index of net output per man-hours in base year prices for the period 1939 to 1953.[24] Private product per man-hour therefore is affected not only by changes in physical productivity but also by shifts in output and employment between sectors of the economy. For example, for the entire period, 1910–53, private product per man-hour increased more than either of its two major components, farm and nonfarm. This reflects the relative shift of activity to nonagricultural pursuits which, on the average have a higher value of output per man-hour than agriculture.

With limitations and differences in mind, the trends in private product per man-hour are shown in table 6.

TABLE 6.—*Average annual percent increase*[1] *in real private product per man-hour*[2]

Period	Total	Farm	Nonfarm
1910–53	2.1	1.8	2.0
1910–39	1.8	.8	1.9
1910–19	.7	.4	.7
1919–29	2.5	1.1	2.5
1929–39	2.5	2.0	2.5
1939–47	2.2	2.3	1.6
1947–53	3.6	3.7	3.4

[1] Average percent changes computed from the least squares trend of the logarithms of the index numbers.

[2] Man-hours are based on estimates for all persons at work, including proprietors and unpaid family workers.

APPENDIX I—TECHNICAL NOTE

INDEXES OF PHYSICAL OUTPUT PER MAN-HOUR AND MAN-HOURS PER UNIT OF PHYSICAL OUTPUT

Concepts and formulation

Indexes of output per man-hour based on physical production data measure the relationship between physical production and man-hours worked by production workers. In concept (if not altogether in practice) the goal is the elimination of such changes as arise from variation in importance of products or industries with high or low value or value added per man-hour.[25]

Physical output per man-hour is a measure of the relationship between physical volume of output and one input factor—labor time. Changes in the relationship reflect the joint effect of a large number of factors such as technological improvement, the rate of operations, changes in the relative volume of production of industrial establishments operating at different levels of efficiency, types of resources and materials available, as well as the skill and effort of the work force, efficiency of management, and the status of labor relations.

Measurement of output per man-hour on a physical basis is often simplified if presented in the form of man-hours per unit of output (unit man-hours), the reciprocal of output per man-hour. When a comparison is made between 2 years, the unit man-hour index shows the change in total man-hours needed to reproduce the actual output of a fixed industrial composition. In the base year weighted series, sometimes referred to as "fixed weight," the total man-hours required to reproduce the base year (1947) industrial composition is measured. The current year weighted series, sometimes referred to as "changing weight," compares the total man-hours in the base year and current year needed to reproduce the actual output of the current year.

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[24] With some minor differences in definition. They are not strictly comparable with manufacturing estimates from the period prior to 1939.

[25] On the other hand, the indexes of net product per man-hour include such interindustry shifts as a basic part of the concept.

The indexes of production, man-hours and output per man-hour for total manufacturing are constructed by combining separate indexes from the more detailed industry data at the 2-, 3-, and 4-digit levels (Standard Industrial Classification Manual, Bureau of the Budget, November 1945).

The industry indexes which comprise the various components of the total, are constructed in concept according to the formula:

Index of unit man-hours$=\frac{\Sigma l_t q_t}{\Sigma l_o q_t}$.

Where l=man-hours used to produce 1 unit of a product
q=number of units (quantity) of a given product
t=current year
o=base year

Actually, the unit man-hour measures are constructed by dividing the man-hour measure of an industry by the industry production measure thus:

Unit man-hours = man-hours ÷ production

$$\frac{\Sigma l_t q_t}{\Sigma l_o q_t}=\frac{\Sigma l_t q_t}{\Sigma l_o q_o}\div\frac{\Sigma l_o q_t}{\Sigma l_o q_o}$$

Because of lack of data on unit man-hours for individual products, it has been necessary to substitute other weights as described on page 323. For combining industry indexes, however, man-hour weights are available and have been used to prepare group indexes, and indexes for total manufacturing. The individual industry measures comprising the group indexes of output per man-hour have been combined in two ways: (1) With fixed (base year) man-hour weights to combine industry measures, (2) with current-year man-hour weights, according to the following formulas.

Base-year weights:

$$\frac{\sum\left(\frac{L_t}{L_o}\right)L_oQ_o}{\Sigma L_oQ_o}=\frac{\Sigma L_tQ_t}{\Sigma L_oQ_o}\div\frac{\Sigma L_tQ_t}{\sum\frac{L_tQ_t}{Q_t/Q_o}}$$

Current-year weights:

$$\frac{\Sigma L_tQ_t}{\sum\frac{L_tQ_t}{L_t L_o}}=\frac{\Sigma L_tQ_t}{\Sigma L_oQ_o}\div\frac{\sum\left(\frac{Q_t}{Q_o}\right)L_oQ_o}{\Sigma\ L_oQ_o}$$

Where:

$\frac{L_t}{L_o}$=industry measure of unit man-hours

$\frac{Q_t}{Q_o}$=industry measure of production

L_oQ_o=base year man-hours

L_tQ_t=current-year man-hours

In arriving at figures for broad industry groupings, several levels of aggregation are involved. Those 4-digit industries which are available for a 3-digit group are combined with man-hour weights to obtain an estimated 3-digit index. The 3-digit indexes are combined to 2-digit by means of weights representing the entire 3-digit group (not merely the represented industries) and similar procedures are applied to obtain the indexes for durables, nondurables, and manufacturing as a whole.

METHODOLOGY

Indexes for 1947 and 1949–53

A total of 152 indexes for the years 1947 and 1959–53 covering 198 of the 460 4-digit industries as defined in the Standard Industrial Classification Manual serves as the basis for the Bureau of Labor Statistics Index for Manufacturing (table 7). These industries represent approximately 72 percent of all private manufacturing[26] employment in 1947. Inadequacy of production or man-hour data prevent the remaining manufacturing industries from being included in the index. However, inasmuch as the industries covered represent a large sample of all manufacturing and include most of the major industries, and since the combined index compares very closely with others independently derived the combined index may be considered representative of manufacturing as a whole. (See also p. 331–332.)

Quantity data are used wherever possible, and more than half the 152 indexes included in the all-manufacturing index, representing nearly three-fourths of the production workers employed by the included industries, are derived from data on the production or shipments of the primary products of the particular industry. A summary of the types of secondary-source data used in developing the individual production indexes is shown in table 8 below:

TABLE 7.—*Physical output indexes of production, 1947–53, industry coverage in terms of 1947 production worker employment*

SIC code	Industry group	Total production workers 1947 (in thousands)	Industries covered by production indexes			
			Number of industries	Production workers		
				Number (in thousands)	Percent of group	Percent of total manufacturing
	Total manufacturing	[1] 11,916	[2] 198	[1] 8,566	----------	[1] 71.8
20	Food and kindred products	1,110	29	1,003	90.4	8.4
21	Tobacco manufactures	103	3	80	77.2	.7
22	Textile mill products	1,110	11	985	88.8	8.3
23	Apparel and related products	1,010	14	687	68.0	5.8
24	Lumber products	596	3	405	68.0	3.4
25	Furniture and fixtures	283	6	204	72.1	1.7
26	Paper and allied products	389	10	380	97.8	3.2
27	Printing and publishing	438	1	118	27.0	1.0
28	Chemicals and allied products	456	17	321	70.3	2.7
29	Petroleum and coal products	170	4	162	95.6	1.4
30	Rubber products	215	3	120	55.8	1.0
31	Leather and leather products	349	6	307	88.1	2.6
32	Stone, clay, and glass products	406	18	306	75.5	2.6
33	Primary metal products	1,010	18	1,002	99.2	8.4
34	Fabricated metal products	823	13	445	54.1	3.7
35	Machinery (excluding electrical)	1,244	18	810	65.1	6.8
36	Electrical machinery	639	10	436	68.3	3.7
37	Transportation equipment	987	9	689	69.8	5.8
38	Instruments and related products	182	2	67	36.6	.6
39	Miscellaneous manufactures	398	3	30	7.5	.3

[1] Components may not equal total due to rounding.

[2] These 198 (four-digit SIC) industries are combined into 152 production indexes for which man-hours data are available on a comparable industry basis. See p. 322 for further description.

TABLE 8.—*Type of data used in measuring production*

Type of data	Number of indexes	Production workers covered 1947	
		Number (in thousands)	Percent of total
Total	152	[1] 8,556	[1] 100.0
Quantity:			
Production	57	4,895	57.2
Shipments	22	1,282	15.0
Deflated value of shipments	57	1,794	21.0
Consumption of materials	16	586	6.8

[1] Components may not equal total due to rounding.

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[26] Activities of Government establishments such as arsenals and shipyards are excluded from the definition of manufacturing.

TABLE 9.—*Type of data used in measuring production by industry groups*

SIC code	Industry group	Type of data							
		Quantity				Deflated value of shipments [1]		Consumption of materials	
		Production		Shipments [1]					
		Number of indexes	Percent of production workers covered	Number of indexes	Percent of production workers covered	Number of indexes	Percent of production workers covered	Number of indexes	Percent of production workers covered
	Total manufacturing	57	[2] 57.2	22	[2] 15.0	57	[2] 21.0	16	[2] 6.8
20	Food and kindred products	8	7.1	2	.9	4	3.3	2	.4
21	Tobacco manufactures	2	.9	------	------	------	------	------	------
22	Textile mill products	6	11.1	------	------	2	.4	------	------
23	Apparel and related products	7	7.4	------	------	2	.6	------	------
24	Lumber and products	2	4.5	------	------	1	.3	------	------
25	Furniture and fixtures	------	------	------	------	5	2.4	------	------
26	Paper and allied products	1	2.0	------	------	------	------	7	2.4
27	Printing and publishing	------	------	------	------	------	------	1	1.4
28	Chemicals and allied products	9	2.9	2	.4	1	.4	------	------
29	Petroleum and coal products	2	1.7	1	.2	------	------	------	------
30	Rubber products	2	1.4	------	------	1	(3)	------	------
31	Leather and leather products	2	3.1	------	------	3	.4	------	------
32	Stone, clay, and glass products	6	2.0	2	.2	5	1.3	1	.2
33	Primary metal products	3	.6	8	10.2	3	.9	------	------
34	Fabricated metal products	1	1.1	------	------	6	1.7	5	2.4
35	Machinery (excluding electrical)	2	2.2	2	1.4	14	5.9	------	------
36	Electrical machinery	2	1.9	3	.8	5	2.3	------	------
37	Transportation equipment	2	7.2	2	.9	------	------	------	------
38	Instruments and related products	------	------	------	------	2	.8	------	------
39	Miscellaneous manufactures	------	------	------	------	3	.3	------	------

[1] Adjusted for finished goods inventories wherever possible.
[2] Components may not equal total due to rounding.
[3] Less than 0.5 percent.

Industry definitions

For the most part, the individual indexes at the 4-digit level are established in accordance with standard industrial classification definitions. In a few cases, two or more of the 4-digit industries within the SIC 3-digit grouping are combined, or 4-digit industries in exceptional cases, are combined across 3-digit and even 2-digit SIC categories.

Source of data

The production data used in measuring the output of the various industries are obtained from a number of public and private agencies. The Bureau of the Census of the United States Department of Commerce, is the most important source, its Facts for Industry series providing data for approximately 50 of the indexes in the years 1947 and 1949–53. The Bureau of Mines' Minerals Yearbook is another important source for a number of industries, including the cement, coke, and nonferrous metals industries. Other sources are the United States Department of Agriculture, the United States Department of the Interior, the United States Tariff Commission, and the Bureau of Internal Revenue. Trade association sources include the Tanners Council, the Textile Economics Bureau, the National Association of Hosiery Manufacturers, the National Canners Association, the Millers National Federation, the National Fertilizer Association, and the American Iron and Steel Institute. Various trade publications, such as, Electrical Merchandising magazine, and Automobile Facts and Figures are also used.

Product detail

In many cases it is not possible to include quantity statistics for all the items produced in an industry, nor is it always necessary to have 100 percent coverage for an adequate representation of the industry's production trends. The Bureau of Labor Statistics uses as much product detail, however, as the availability of output data and weights permit. In all cases the value of the output represented in the index constitutes at least 50 percent of the total value of the industry's products, and in 38 cases is over 80 percent.

In constructing the indexes, new products and important changes in product specifications are taken into account when they are reported to collecting agencies. Weights for new products are usually estimated, based on their man-hour or value relationship to products previously reported.

Unit of measurement

The choice of the unit in which the production is measured is necessarily limited by the way in which the collecting agency reports the data. Frequently a choice of unit does exist, however. For instance, in the textile industry the output of cloth can be measured in linear yards, square yards, or pounds. Where choice exists, the Bureau tries to select the measure which is most nearly related (i. e. proportional) to the man-hours used in its production.

Weights

In order to measure the output of the various industry components, production indexes are constructed. Data representing production of the various products of an industry are combined by means of weights—usually 1947 unit values but preferably unit man-hours.

Theoretically unit man-hour weights are preferable for a production index designed to measure output per man-hour. Practically, unit man-hours are available in individual product basis in only a few large industries such as steel, paper and pulp, and cement industries. Where unit man-hour data are lacking, data on unit labor costs, unit value added or unit value, in that order of preference, are used. Where weights other than unit man-hour data are used, the Bureau attempts to test them, to determine whether they are to some degree proportional to labor requirements.

A summary of the types and importance of weights used in combining product data is shown in table 10.

TABLE 10.—*Type of weight used in combining products in industry indexes*

Type of weights	Number of indexes	Production workers covered, 1947	
		Number (in thousands)	Percent of total
Total	152	[1] 8,556	[1] 100.0
Unit man-hours	8	1,123	13.1
Unit labor cost	2	282	3.3
Unit value added	10	742	8.7
Unit value	49	3,770	44.1
Unweighted [2]	15	449	5.2
Deflated value of production	57	1,794	21.0
Other	11	396	4.6

[1] Components may not equal total due to rounding.

[2] Sometimes described as "equally weighted."

Deflated value of shipments indexes

Deflated value indexes for some industries are constructed from the value of shipments data published in the Annual Survey of Manufactures by the Bureau of the Census, deflated by an industry wholesale price index.

A contrast exists between the production covered by physical volume indexes and that serving as the base for deflated value indexes. The physical volume indexes are based on the output of all primary products, whether made by the industry to which primary or by other industries. The deflated value indexes, on the other hand, are constructed from value of shipments data which relate to the total value of products shipped by the industry itself, including secondary as well as primary products, but excluding primary products made outside the industry. The price indexes used in the deflators of these industries, however, refer only to primary products.

Consumption indexes

The Bureau also estimates output measures in some industries on the basis of the physical volume of materials consumed. Consumption provides a satisfactory indicator of production trends in those industries where no significant change has occurred in the amount of material consumed per unit of final output. No tests have been made of this relationship for these industries.

Benchmark indexes, 1939 and 1947

In 1939 and 1947, comprehensive censuses of manufactures were collected by the Bureau of the Census, United States Department of Commerce. The BLS has drawn heavily upon census data in constructing its "benchmark" indexes which compare production and output per man-hour in the 2 years 1939 and 1947. There are 152 benchmark indexes, representing 207 four-digit SIC classifications and covering 66 percent of the 1947 production workers.

The indexes for the years 1939 and 1947 are for the most part based upon production or shipments data.

In a few cases the benchmark indexes are not based upon physical volume but are constructed from estimates of consumption (9) or by deflating value of shipments data (18). The same methods of constructing these indexes are used as described above with respect to the indexes for the later years.

Adjustment for inventory change

In some industries the only available output data are shipments of finished goods, rather than production. To the degree that manufacturers' inventories change from year to year, noncomparability of man-hours and output indexes may arise, so where data were available an adjustment was made to take care of the situation.

An adjustment for finished goods inventories was made for 72 of a total of 79 industries in which (1) output is measured by means of deflated value of shipments or (2) physical quantity of shipments data are used. Adjustments were not made where output is measured by production or consumption because it would not be necessary, nor where mixed production and shipments data make it impossible.

The adjustment was applied, where possible, to all years included in the index except 1949, a year for which beginning-of-year inventory figures were not available.

Goods-in-process inventory adjustments were not made, partly because the concept of measurment of physical output involves production of completed goods (e. g., production of items rejected on inspection would be excluded) and in part because adequate data are not available on a comparable industry basis.

These comments apply only to the physical output measures. In the value added measures, adjustments for finished goods were made at the industry level. Adjustments for goods-in-process inventories were made at the total manufacturing level covering all industries.

Adjustment for military production

The production of purely military products in an industry normally producing civilian goods is not reported in the usual statistical tabulations of production data. The Bureau has been able, by means of special tabulations developed in conjunction with the Federal Reserve Board (based on data of the Bureau of the Census), to make an adjustment to correct for the downward bias caused by the increase in military production in industry groups affected—metalworking and clothing. This type of adjustment is applied at the individual industry level to the indexes based on physical volume. (The deflated value series such as those comprising the index based on net product did not require this type of adjustment because the value figures include the military output.)

Work-stoppage adjustment

For the year 1939 stoppages give rise to some noncomparability between output and man-hour indexes. For that year the man-hours indexes were derived from census employment data and BLS average weekly hours. Since the hours figures were collected from plant records for the payroll period (week) ending nearest the 15th of each month, this sample week may have been unrepresentative of average hours expended during the month in which a stoppage occurred. However, the reported pay period may either overestimate or underestimate the hours. This type of discrepancy will tend to be random among plants, and among industries, and consequently, no bias is introduced into the manufacturing index even if no adjustments are made. The net result for all manufacturing or even for two-digit industries is likely to be inconsequential; hence the Bureau has looked into those industries which may be published separately at some future date, and in which major work stoppages occurred. The correction was made only if the adjusted figures differed from the unadjusted figures by more than 1 percent because it was recognized that the data on which the adjustment was based were not sufficiently refined to justify adjustments of a fraction of 1 percent. This occurred only in SIC 2062, cane sugar refining, and SIC 371, motor vehicles.

Beginning with 1947, no adjustment was necessary, because the man-hour indexes were based on Bureau of the Census man-hours, which are not subject to the potential error of the sample week, as the BLS figures are.

Product coverage changes

The indexes are rarely constructed from data representing the entire output of the industry. Varying proportions of secondary production are unreported; furthermore, some of the production figures are on a "wherever made" basis; i. e., include quantities which are made as secondary products in other industries. Man-hours, however, are reported on an industry basis so failure of production and man-hours figures to match may result. However, it is not the actual amounts of secondary production and production made in other industries that is the key to the problem. Rather it is the change in the proportion of such production which is important. The Bureau has examined the various component indexes of production and for the years 1939 and 1947 has made an adjustment to correct for changing coverage in a number of industries where this seemed warranted. These adjustments are of the same type as those made by the Bureau of the Census in its publication Census of Manufactures, 1947, Indexes of Production, and those of Solomon Fabricant in Output of Manufacturing Industries. They are based on adjustment of the physical output indexes by the 1939 and 1947 ratios of value of items in the index to total value of the industry's products.

The conceptual basis of this type of adjustment is that the price movements of items not covered move in the same way as prices of included items. Rather than make this assumption for all products, the Bureau has assumed that prices of products normally classified in the industry generally move together, whether or not the products were all made in the industry. The same assumption was not uniformly made with respect to the secondary products, however, whose prices may move in accord with prices of the "home industry" rather than with prices of the industry in which they are made.

Accordingly, the following standards were established for acceptance or rejection of the coverage adjustment for the 1939 data:

1. If the adjustment factor was less than 5 percent, no adjustment was made. The error in the basic data underlying the adjustment might be sufficient to invalidate the adjustment.
2. If the adjustment was between 5 and 20 percent it was accepted if caused principally by changes in the proportion of value of primary products made outside the industry. If the magnitude of the coverage factor was principally due to changes in proportions of secondary production, no adjustment was made.
3. The few cases in which the adjustment amounted to 20 percent or more were subjected to special attention. Any information available covering price movements and other special knowledge or judgment was used to determine whether the index should be adjusted, remain unadjusted, combined with data for other industries or abandoned. Two of nine industries given this attention were dropped.

It should be noted that some industries were combined because of overlapping of production before the question of coverage adjustment was considered.

Limitations

The indexes set out to measure the ratio of production of all products of an industry to all production worker man-hours in the industry. As the closest possible approximation of this, the production index usually measures the output of primary products of the industry wherever they are made, the most generally available form of data. To the extent that the industry's primary products are made elsewhere and that the industry makes secondary products the indexes may contain a bias.

Production and labor data must be comparable if output per man-hour measurement is to be reliable. Two principal causes of lack of comparability are: (1) production data may not include the entire output of an industry or (2) the production figures include some quantities made as secondary products in other industries. Inasmuch as man-hour data are on an industry basis noncomparability can result.

The most appropriate weights for a production index to be used for this purpose are unit labor requirements for the products measured. When these are not obtainable, alternative weights are used. These alternatives, in order of desirability, are unit labor cost, unit value added by manufacture, and unit value. The most generally available of these are the unit value weights. To the extent that the unit values used are proportional to the unit labor requirements, they represent unit labor requirements.

Such intangibles as quality change cannot be taken into account. To do so would involve assigning values to consumer preference and utility. Since, on the whole, the quality of goods is improving the indexes understate gains in productivity (in exceptional periods such as wartime an opposite bias probably occurs). For example, although some account is taken of the increasing importance of automatic transmissions in automobile production, it is not possible to measure the gains in such characteristics as ease in riding, safety, roominess, and general appearance. Many quality improvements require increased man-hours in the production process but are not reflected in production measures. This limitation, of course, is a limitation on production measurement itself and it is common to all indexes of production and prices.

Another data problem which may affect the physical-output indexes (but not the value-added indexes) is that of plant integration. As plants become more integrated, that is, produce more of the components used in the manufacture of the final product, the volume of items reported as production tends to decline. As plants become more specialized, that is, purchase more components from other establishments, the volume of items reported as production tends to increase. This type of activity could result in acute problems of measurement in a single industry. However, integration and specialization are occurring among all industries and, although not measurable, it is believed that the net effect on the total manufacturing sector is small.

Certain rigidities imposed by industrial classification also affect the measures. As plants shift major production from one type of goods to another, they may be reclassified from one industry to another. Changes in indexes of output per man-hour or unit man-hours for a single industry could result from such changes in classification and consequently could be misleading as to changes in economic activity. However, as measurement moves from the single industry to industry groups, the importance of changes in industrial classification diminishes and is considered to be relatively insignificant for the total manufacturing sector.

New products often are not included in the production indexes until they become important enough to be reported to the Bureau of the Census. When the BLS receives information on new products it adds them to the composite of output, attempting to determine when they were first manufactured and treating them as zero for the years preceding. Interpolation may be required when complete information is not available. Sometimes new products are included as a part of another product class, until they become important enough for separate reporting. In this case they are linked into the index.

INDEXES OF NET OUTPUT PER MAN-HOUR AND MAN-HOURS PER UNIT OF NET OUTPUT

Concepts and formulation

The concept of net output relates to the value added in the course of the manufacturing process and is an indicator of the volume of work done. Net output is equal to the value of goods sold by establishments in an industry or transferred to other plants of the same company plus the net change in finished goods and goods in process inventories (i. e., gross output) less the value of purchased goods and business services consumed in production. Indexes computed from the deflated aggregates reflect changes not only in the physical volume of gross output but also in the quantity of materials consumed.

Since the measure for each industry includes only work done by that industry, the net output of industries at successive stages of fabrication can be added together without counting the contribution of any industry more than once. Thus, in combining the net outputs of the steel and steel-fabricating industries, the value of steel is added only once. The value of net output of manufacturing as a whole is the unduplicated sum of the net output of individual component industries.

To measure relative change the annual value of net output in current dollars is corrected for change in price. Since commodity-price indexes are not appropriate for correcting directly the value of net output, the value of gross output and materials consumed are deflated separately. The difference between the two values is the net output adjusted for price change.

The net output per man-hour index for manufacturing may be expressed algebraically as follows:

$$\frac{\sum^{S}\left(\sum^{N} q_t p_w - \sum^{M} Q_t P_w\right)}{\sum^{S}\left(\sum^{N} q_o p_w - \sum^{M} Q_o P_w\right)} \div \frac{\sum^{S}\left(\sum^{N} q_t l_t\right)}{\sum^{S}\left(\sum^{N} q_o l_o\right)}$$

The first term is an index of net output where S is number of industries covered; N, number of products produced in an industry; M, number of goods consumed in an industry; q, quantity of a good produced; p, price of a good produced; Q, quantity of a good consumed; P, price of a good consumed. The term on the right is an index of man-hours worked, where l is the unit man-hour requirements for a good produced. The subscripts o and t in both terms refer to base and current years, respectively; w in the first term relates to the period used in correcting values for price change.

Relation to national income accounting

Within the framework of national income accounting the concept of manufacturing net output represents the portion of the gross national product originating in the sector. Trends shown by the net output series are directly comparable with the gross national product for the economy. Both concepts exclude the value of intermediate products consumed in production and are, therefore, considered net measures. Since no deduction is made for the consumption of durable capital goods, both measures are also described as "gross." Net output of manufacturing is a more inclusive concept than national income originating in manufacturing which measures net product in terms of factor costs only, exclusive of capital consumption and other nonfactor payments.

Because of the nature of the available data on gross output and goods consumed, the net output measure actually used in this report is a close approximation, but not precisely identical to the net output concept. The BLS measure takes account of the net change in both finished goods and goods in process inventories. In this respect BLS net output differs from census' value added estimates which generally take no account of inventory change.

Also in BLS estimates of net output based on census data only the costs of materials, supplies, containers, fuels, contract work, and purchased electrical energy are deducted from the value of gross output. Owing to the lack of data, no deductions are made for the cost of business services, such as insurance, advertising, communications, and repair and maintenance by contractors. These costs are included, therefore, in the BLS net output, but not in the theoretical concept. Finally, the BLS net output measure excludes certain indirect business taxes paid by manufacturing establishments which theoretically should be covered. Although these taxes and the cost of business services constitute a significant item in some industries, they are a relatively small fraction of total manufacturing costs.

Relation between net and gross output indexes

Indexes of gross and net output for an industry are identical only if relative changes in gross output and material consumption are the same. If the consumption of materials rises relative to finished goods output, the gross output index will advance relatively more than the net output index. If an industry achieves economies in the amount of materials used per unit of gross output, the net output index will register a greater relative advance than an index based on gross output alone.

The last case is illustrated by the following tabulation:

	Value in constant prices		
	Base year	Given year	Index
Gross output	$200	$400.00	200
Materials consumed	100	150.00	150
Materials consumed per $100 of gross output	50	37.50	75
Net output	100	250.00	250

The BLS net output index for manufacturing is computed from net rather than gross output estimates for individual industries. It differs therefore from such series as the Federal Reserve Board Index of Production for total manufactures which attempts to approximate net output series by combining industry gross output indexes with value added weights.

Interpretation

Indexes of net output per man-hour, relating changes in the volume of work done in an industry to changes in the volume of labor input, are statistical measures of the performance of the entire production process. Like other ratios of production and labor, they do not imply that labor or any other input factor is responsible for gains or losses in production. A large number of factors, as indicated earlier, must be taken into account in explaining changes shown by the series.

In interpreting the series, it is important to keep in mind certain characteristics of the net output per man-hour indexes. Changes in the indexes reflect not only changes in physical output per man-hour but also certain shifts in the distribution of output and materials consumed among products, plants, and industries.

Indexes of net output per man-hour reflect changes in efficiency of utilizing materials in production. Thus, if the volume of materials and fuels consumed per unit of output declines, due to improved processing in the industry, with no change in the finished goods output, the net output per man-hour index shows a rise. Conversely, the net output per man-hour index declines, if material consumption per unit of output rises.

If products with relatively high value added per man-hour become more important in an industry's output, the net output per man-hour index for the industry may register an increase without any change for any particular product. Similarly, a shift in output from industries of low to high net output per man-hour may be reflected as an increase in the index for manufacturing, without any change in the index for any particular industry. In both cases, shifts in the opposide direction may result in corresponding changes in the group index.

It should be noted that greater integration of fabricating activities, resulting in a net reduction in the amount of semifinished materials purchased by plants in an industry with no change in finished goods output, means a rise in the net output index as well as the man-hour index for the industry. Conversely, with a net increase in the extent of the specialization within plants, indexes of both net output and man-hours decline, with no change in industry gross output. Gross output per man-hour series in these cases may show spurious changes which are due only to difference in integration not related to actual changes in efficiency. Net output per man-hour indexes, therefore, offer a means of meeting some of the difficulties of measurement presented by gross output per man-hour series when the degree of integration within plants is changing.

SOURCES AND GENERAL METHODS

The first step in deriving indexes of net output per man-hour for manufacturing is to obtain annual estimates of net output (adjusted for price change) by individual industry. In the absence of production and material input data for estimating value added by individual product, the detailed industry approach to deflating is adopted as the next level of aggregation. For manufacturing as a whole, net output estimates are derived by summing data for individual industries. Indexes are constructed from the annual total by using the year 1947 as the base date. The net output per man-hour indexes for manufacturing as a whole are obtained by dividing annual net output indexes by corresponding man-hour series.

Sources of data

In estimating net output for 1947–53 the BLS utilizes the data on dollar value of shipments, finished goods, and goods in process inventories and cost of materials for individual industries from the 1947 Census of Manufactures and the Annual Survey of Manufactures for 1949–53. Published data from these sources are supplemented by unpublished tabulations and by special estimates. Totals for manufacturing cover virtually all of the 453 census industries. For 1939, data on value of production and cost of materials were obtained from the 1939 Census of Manufactures.

The census industry estimates cover the total activity of establishments specializing in the products or activities defining an industry. Data on value of shipments and costs of materials therefore relate both to products primary to the industry and to secondary products or items made primarily in other industries.

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To correct annual 1947–53 data on values of shipments for price changes, indexes are specially constructed from the BLS Wholesale Commodity price series. These price indexes based on data for 1,800 specific products are classified by producing industry and averaged into industry indexes. Since the commodities represented in the industry index are those primary to the industry, it is assumed that the price movement of secondary products follows those for primary products. The weights used in combining product indexes are based on value of shipments data from the 1947 Census of Manufactures. For the 1939–47 period, implicit price indexes are derived from the detailed industry production indexes developed by Census and Federal Reserve Board for the period.

To correct the annual value of materials consumed for price changes, an index of the prices paid for goods consumed by each industry is required. A basis for constructing these cost deflators is provided by the BLS interindustry chart which shows the particular industries from which each industry purchased goods and services in 1947 and the actual value of such purchases. For the period 1947–52 cost deflators are constructed for each industry by averaging the price indexes for supplying industries (as described above) with weights based on the value of purchases in 1947 by the consuming industry. For 1939 and 1953, deflation of cost of materials is done at the total manufacturing level, rather than by separately deflating individual industries and then aggregating. This is based on a special tabulation of the value of purchases by all manufacturing industries from each producing industry.

Method of estimation and adjustment

The Bureau has prepared two types of manufacturing net output indexes on the basis of the data described above: (1) An index of net output, 1947 equals 100, in base year (1947) prices; (2) an index of net output, 1947 equals 100 in current year prices.

The former series is obtained by first dividing the dollar value of shipments and cost of materials, for each manufacturing industry for 1949 through 1953, by appropriate price indexes and summing the deflated values for all manufacturing industries. The annual net output (in constant dollars) for manufacturing is then derived as the difference between the two totals. The index is based on the ratio of the given year net output to the 1947 total. Since the price index used is constructed with 1947 rather than given year quantity weights, the result is an approximation to the theoretically correct series.

The second index, with given year price weights, is constructed by multiplying 1947 value of shipments and cost of materials by appropriate price indexes for each of the years 1939, and 1949 through 1953. The net output total for each year is obtained as the difference. The index for each year (1947 equals 100) is obtained by dividing net output in given year prices by the 1947 total in given year prices. Since only the given year and base year figures are comparable, indexes for adjacent years may not be validly compared.

To derive estimates more consistent with the net output concept and to improve their accuracy, several important adjustments of the data are made. First, estimates of the value of shipments (in constant dollars) are adjusted to include the constant dollar value of the net change in finished goods and goods in process inventories. Census and Annual Survey of Manufactures data on beginning and end of year book values of finished goods inventories for 1947 and 1950 to 1953 are deflated by industry indexes as of the end of the year. Since the Bureau of the Census does not provide separate annual data on goods in process inventories prior to 1953, special estimates of these inventories were developed by applying ratios based on Office of Business Economics series on inventories, by stage of fabrication, to census published totals of inventories to goods in process and materials.

The indexes for deflating the cost of materials are based on price quotations at the producers level and may not reflect changes in such costs as freight charges paid by consuming industries. To derive a more appropriate deflator of materials costs, the material price index for manufacturing, described above, are combined with appropriate freight rate indexes published by the Interstate Commerce Commission. The weights used in combining the indexes are determined from the 1947 value of purchases by manufacturing industries, based on the data shown in the BLS interindustry table.

Limitations

Although it is not possible to calculate precisely the margin of error of the net output per man-hour index, a review of some factors affecting the reliability of the estimate provides some basis for a qualitative appraisal of the results.

The basic annual census data on dollar value of shipments, inventories, cost of materials and man-hours, collected by means of a sample survey are subject to sampling error. For some industries, the sampling error is large but for manufacturing as a whole, it is relatively insignificant. In addition, census estimates are subject to an unknown degree to errors of reporting.

Other sources of error in net output estimates are the imperfections of the price indexes used in deflating current dollar values. BLS price indexes are based on quoted rather than actual prices and therefore may not be representative of the changes in monetary values embodied in the census values. In constructing the index for deflating industry shipments, some error may be introduced because the price movements of a selected number of products may not be precisely representative of the movement of all products of the industry.

Because it is generally impossible to express in commodity specifications certain qualitative aspects of goods priced, such as appearance or ease of operation, a commodity considered identical for price comparisons may actually change over time. If improvements in quality occur, the price change tends to be overstated and the change in output derived by deflation, therefore, understated. Conversely quality deterioration introduced a downward bias in price indexes and an upward bias in the output series. Although it is generally believed that the quality of goods on the whole has improved over the long term, the nature of short run changes is somewhat uncertain.

In developing the material cost index, it is assumed that an index of average prices for a supplying industry is representative of the particular product or group of products purchased from that industry by a consuming industry. Also because of the lack of data, no account is taken of changes in trade margins.

Finally, since net output is calculated as the difference between gross ouput and materials consumed, the error in the residual for industries may be larger than in the two totals from which it is derived. There is no reason to suppose, however, that any general bias is introduced by this procedure.

MAN-HOUR STATISTICS

A basic step in calculating indexes of output per unit of labor input is the measurement of man-hour trends. In constructing the series based on physical output, production worker man-hour statistics for individual industries are used not only in deriving industry man-hour trends but also for weighting industry indexes into groups. In the net output approach the net output index is related to a man-hour index for total manufacturing.

Concepts

Labor input is measured in terms of the man-hours of production workers, with no distinction made between time worked by different skill groups. Man-hours are treated as homogeneous and additive. While this type of measure is particularly relevent to problems of estimating man-hour requirements, it is recognized that an index reflecting changes in the relative importance of skill groups would also have economic significance. As in the problem of reflecting quality changes in output discussed earlier, quantitative data on quality changes in labor input are not generally available.

Sources and methods

The sources of data used in constructing man-hour indexes are the 1947 Census of Manufactures and the Annual Survey of Manufactures for 1949–53, inclusive. To make the 1947 census data for manufacturing comparable in coverage with annual survey data, special estimates are made for industries omitted in 1947 and undercovered in 1949 and 1950. The man-hour data used in the physical output per man-hour series for manufacturing cover all manufacturing except ordnance industries. Because of the lack of comparable census man-hour data for 1939 and 1947, special estimates of industry man-hour trends are calculated from census data on production worker employment and BLS data on average weekly hours. No data are available for computing indexes in terms of all employee man-hours.

Definition of production and related workers

The term "production and related workers" covers working foremen and all nonsupervisory workers, including leadmen and trainees, "engaged in fabricating, processing, assembling, inspection, receiving, storage, handling, packing, warehousing, shipping, maintenance, repair, janitorial, watchmen services, product development, recordbreaking, auxiliary production for plant's own use (e. g., powerplant operations) and other services closely associated with the above production activities of establishments." The term thus includes some indirect as well as direct plant labor.

The Bureau of the Census also provides annual data on all employees, covering, in addition to production and related workers, nonproduction personnel of the plant engaged in "executive, purchasing, finance, accounting, legal, personnel, cafeterias, medical, professional, and technical activities, sales, sales delivery (e. g. routemen), advertising, credit, collection, installation and servicing of own products, routine office functions, and factory supervision above the working foreman level." Force-account construction workers are also included. The all employee group is broader in scope than the total of direct and indirect plant labor, as defined in industry cost accounting practice.

Definition of man-hours

The census data on man-hours cover "all man-hours worked or paid for" at the plant by production and related workers only, except hours paid for vacations, holidays or sick leave, when the employee is not at the plant. Other hours paid for but not actually worked, such as standby or reporting time, rest periods, portal to portal, clothes change and washing time, however, are included. Hours worked for which premium pay is received, such as overtime, night, Sunday, holiday work, are included on the basis of actual time worked, rather than in terms of straight time equivalent hours. The definition calls for actual hours worked or paid for, not scheduled or standard hours. Time lost at any time during the year because of strikes, disasters, shutdowns, etc., is not included in the estimates. The census does not collect data on man-hours worked by nonproduction workers employed at the plant.

The census man-hour concept differs from the Bureau of Labor Statistics definition of man-hours which covers hours paid for vacations, holidays, and sick leave. Because of errors in reporting, however, the census concept probably includes some of these man-hours.

Man-hour estimates for 1939–47

To derive man-hour indexes for 1939 and 1947, a number of important adjustments of the available data on employment and average weekly hours are required. Although comparable man-hour figures are not available, the Bureau of the Census retabulated and published estimates of production worker employment on a comparable basis. The published production worker estimates for 1939 and 1947 for some industries, however, are not strictly comparable because of changes in the reporting of certain types of distribution workers.

A first step is to develop comparable production worker employment estimates for these industries, utilizing production worker—all employee ratios developed by the BLS from plant reports to the BLS employment statistics program and comparable 1939–47 all employee estimates as published in the census publication, Indexes of Production. Second, the BLS developed more or less comparable estimates of 1939 and 1947 average weekly hours on the basis of BLS data for both years for selected industries, 1947 Census of Manufactures man-hour data, and a special tabulation of 1939 census man-hour statistics for selected industries. Man-hour indexes for 1939 (1947=100) are calculated from the 1939 and 1947 totals, derived by multiplying the production worker employment by average weekly hours.

Evaluation of results

Since the census man-hour data are based on reports from a sample of establishments, the estimates are subject to sampling error. For manufacturing as a whole and for broad groupings of industries, the margin of error is relatively small. Where the production data for an industry or group of industries are drawn from the same annual survey, the sampling error in the ratio and the index may be smaller than the sampling errors for production and man-hours separately. Finally, because of the extent to which it was necessary to depend on inferences, the man-hour indexes for the period 1939–47 may be subject to a larger margin of error than those for the 1947–53 period.

APPENDIX II. DESCRIPTION OF TESTS AND STANDARDS

COMPARISONS WITH RELATED SERIES

In addition to the 4 indexes which are published in this report, 5 other indexes were computed for comparision purposes. Four of these are prepared from

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production indexes with base-year weights, roughly comparable to the two BLS measures which also use base-year-weighted production indexes. They include two indexes based on deflated value of industry output, combining the industries in one case with man-hour weights and in the other with value-added weights. These indexes cover all industries and the value of output includes both primary and secondary production. A third index is based on deflated value of primary product wherever made, with base-year man-hour weights. This index has a lower coverage (85 percent) than the other based on deflated values. Another output per man-hour index is based on the Federal Reserve Board index of manufacturing production. The four comparision indexes show a small range of 119 to 121 for the year 1952.

Another index was computed using deflated values of Office of Business Economics estimates of manufacturers' sales and inventories. This index was 117 in 1952 but is a current-year-weighted index and therefore more nearly comparable to the two BLS measures which use current-year weights in the production index and which are generally lower than the others.

As a further check related to the problem of price deflation, two price indexes for total manufacturing were constructed using industry price indexes but combining them with different industry weights. In one case the value of industry production was used as weights, on the other primary product wherever made was used as weights. The two weighting schemes yielded practically identical indexes. (See p. 334.)

The above comparison indexes and tests provide strong evidence that any errors or biases which exist in the measures for individual industries do not result in a systematic error of all industries, and that no significant bias exists in any of the four published manufacturing indexes. All of the measures contain a probable bias owing to quality change—in this respect they share a characteristic common to production and price statistics generally.

PHYSICAL OUTPUT PER MAN-HOUR INDEXES

Coverage of the production indexes

The BLS indexes cover industries employing about 72 percent of total production workers in manufacturing. In preparing its indexes the BLS has adopted certain acceptance standards for individual industries. If any industry falls below these standards, the data are rejected. In order to be acceptable, an industry index component, for example, must be based on data for at least 50 percent of the industry's output in terms of 1947 value. In only 8 industries, of the 79 in which quantity data are used, is coverage as low as 60 percent, and in 38 it is 80 percent or higher. This standard of acceptance is somewhat more severe than that used by many others. The BLS applied this standard, however, on the principle that more care with the basic data is required in the field of productivity measurement—where the final result is based on the ratio of output and input (man-hours) series.

Product coverage changes

As indicated earlier the indexes are rarely constructed from data which cover the entire output of an industry, and generally the production of primary products is reported on a wherever-made basis (i. e., quantity of products of the industry actually made in the industry plus the quantity of primary products made as secondary output of other industries). Failure of production and man-hours to match may result. However, it is not the actual amounts of secondary and primary production made in other industries which affect the productivity measures; it is the change in the proportion of such production which is important.

Actions taken with respect to this problem include the following:

(1) *Combination of industries.*—In a number of instances large amounts of products primary to a particular 4-digit industry may be produced in other industries of the same 3-digit group, and secondary production of the particular 4-digit industry may consist largely of products primary to other 4-digit industries in the same 3-digit group. In such situations the 4-digit industries are combined, thus removing the problem for this group of industries. This is one of the principal reasons why the 198 four-digit SIC industries covered directly in the manufacturing index are represented by only 152 separate indexes.

(2) *Coverage requirement.*—Industries in which primary products made within the industry constitute a very small proportion of total value of output (of the industry) are eliminated under the standards for coverage. (See p. 310.)

(3) *Adjustment.*—As indicated earlier, the Bureau has examined the various component indexes for the years 1939 and 1947, and has made adjustments to correct for changing coverage in a number of industries. These adjustments are of the same type as those made by the Bureau of the Census in its publication

Indexes of Production, and those of Solomon Fabricant in Output of Manufacturing Industries. They are based on adjustment of the physical output indexes by the 1939 and 1947 ratios of value of items in the index to total value of the industry's products.

The effect of the adjustment for coverage was not substantial for the period covered. Shown below is a comparison of various indexes for 1939 for total manufacturing. The published production index is the physical volume index prepared with base-year (1947) weights (table 3); selected industries are adjusted for coverage according to the standards previously listed. In the adjusted index all of the industry components for which appropriate data are available are adjusted for coverage. In the unadjusted index none of the components are adjusted. The maximum index represents a combination of the higher of the adjusted or unadjusted industry component indexes. The minimum index combines the lower of the two indexes for each industry.

Comparison of production indexes

Type of index:	*1939 index (1947=100)*
Published	59.4
Adjusted	59.1
Unadjusted	59.7
Maximum	60.3
Minimum	58.5

Weights

When the purpose of productivity measurement is to derive a relationship between physical output and man-hours, unit man-hours are preferable as weights because the resulting output indexes are then not influenced by shifts in the relative importance of products or industries. However, unit values were used in most instances in construction of the individual industry indexes. Work and observation on this question has gone forward in several ways, including the following:

(1) *Comparisons based on unit man-hour data from the BLS direct reports program.*—Unit man-hours and unit value information for a few products made in a few plants and industries were available from the Bureau's direct reports program. Statistics of production for plants in the following industries were combined for the years 1949, 1950, and 1951 with both weighting systems: Machine tools, mining machinery, industrial equipment, metalforming, construction machinery, leather, and electrical household appliances. A standard "t" test revealed that there was no significant difference between the weighting systems for the period. This test, however, is too fragmentary to be conclusive.

(2) *Purposive review of the weights in selected industries.*—BLS analysts with field experience in plant level studies (e. g., the factory performance reports) reviewed the industries for which unit value weights were used, and selected those in which, in their opinion, unit values might not be proportional to unit man-hours. As a result of this selection, 16 industries were subjected to weight review; that is, companies in these industries were requested to evaluate the weights or to furnish unit man-hours. As a result, the following information has been received and action taken:

	Number of industries
Unit values proportional to unit man-hours	2
Unit man-hours data received and substituted	2
Unit man-hours data being developed for future use	1
Unit values adjusted to accord more nearly with unit man-hours	5
No information available	6
Total	16

(3) *Comparison of industry estimates.*—There are 8 industry components (of the manufacturing index) prepared with use of man-hour weights. In 7 of the 8 industries, production indexes for 1952, computed with use of unit value weights, differed by plus or minus 5 percent or less from those constructed with man-hour weights. In one case the difference was 16 percent (26 index points). For this group of 8 industries 2 combined production indexes were constructed, one by using the unit-man-hour weighted indexes, the other by using the unit-value weighted indexes. They differ by less than 1 percent.

(4) *Studies of productivity made by the national research project.*—These studies, prepared in the late 1930's, contain the following statement about unit value and unit man-hours:

"Since value weights were used predominantly, an attempt was made to test their proportionality to the preferred labor weights. Usually the comparison could be made for only a few products classified otherwise than in the NRP index; frequently the comparative weights depended upon crude estimates which detract from the conclusiveness of the test. In all, comparisons of different weighting systems or indexes embodying them were made for 11 industries. In several instances the value weights were found to be fairly proportional to the preferred weights; even where they were not, the indexes based on the two sets of weights were similar. The reason may be that any weighting system would have little influence in the index for an industry where one product dominates, where the several products have the same movement, where the dispersion of the weights is small, or where the number of products is large. It appears from experiments made in the course of the derivation of the NRP measures, furthermore, that weighted indexes of the same scope but dissimilar degrees of detail frequently have the same general movement and that unweighted indexes, which are tantamount to relatives of but one product, frequently exhibit the same general movement as weighted measures. These considerations lead us to believe that the substitution of unit-value for unit-labor requirement weights results in satisfactory production measures for most of the industries. It should not be inferred that the problems of weighting and classification may therefore be neglected. On the contrary, the year-to-year differences in magnitude and direction may be sufficient to preclude the use of indexes based on less detailed classifications for the measurement of short-term changes in production and productivity." [27]

NET OUTPUT PER MAN-HOUR

Deflating industry value of shipments

The price deflators are based on each industry's value of primary products but applied to the total value (primary and secondary) of the industry's output. To evaluate this aspect of the work two price indexes for deflating the total output of all manufacturing were constructed for the year 1952. Both indexes were prepared from the industry price indexes based on product wherever made. In one, the individual price indexes were combined using total value of industry output, primary and secondary, as weights. In the other, value of primary product wherever made was used as the weight. If there were a serious bias in the basic technique it would show up in this test. Actually, the two weighting methods yielded practically identical results.

Cost of materials

A rough check was made on the assumption that an index of average materials price change for a supplying industry represents the particular selection of products purchased by the consuming industry.

A materials price index was constructed in which the value of inputs from the producing industry to all manufacturing was deflated by the producing industry price index, and these were summed to total manufacturing. For example, the total value of steel consumed by all manufacturing was deflated by a steel industry price index and this was added to other products deflated in a similar way. This method of computation yielded results very similar to those obtained in the individual industry approach. A small difference which occurred was due to different assumptions concerning the price movement of items such as transportation costs and trade margins not explicitly priced in the industry measures (but covered for total manufacturing).

The subcommittee will stand in recess until tomorrow morning at 10 o'clock in this room.

(Whereupon, at 3:12 p. m., Monday, October 24, 1955, the subcommittee was recessed to reconvene Tuesday, October 25, 1955, at 10 a. m.)

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[27] Production, Employment and Productivity in 59 Manufacturing Industries. pt. 1, p. 39, National Research Project, Works Projects Administration.

AUTOMATION AND TECHNOLOGICAL CHANGE

TUESDAY, OCTOBER 25, 1955

Congress of the United States,
Subcommittee on Economic Stabilization of the
Joint Committee on the Economic Report,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Wright Patman (chairman) presiding.

Present: Representative Wright Patman, chairman of the subcommittee, and Senator Ralph E. Flanders.

Also present, Staff Economist William H. Moore and Staff Director Grover W. Ensley.

The Chairman. The subcommittee will please come to order.

We have Mr. J. A. Beirne, our witness this morning.

Within the memory of most of us, we have witnessed the introduction of the dial telephone, and if one thinks at all about such things, one is forced to wonder about what happened to all of the friendly, efficient telephone operators in large and small towns who used to handle our calls.

Your industry, of course, Mr. Beirne, is one that has been growing very rapidly as the country grows and as we become more and more dependent upon the telephone. We will be interested how your union views this trend and especially the outlook.

You may proceed in your own way, Mr. Beirne.

STATEMENT OF JOSEPH A. BEIRNE, PRESIDENT, COMMUNICATIONS WORKERS OF AMERICA, ACCOMPANIED BY WILLIAM DUNN, ASSISTANT TO THE PRESIDENT, CWA, AND SYLVIA GOTTLIEB, RESEARCH DIRECTOR, CWA

Mr. Beirne. Thank you. My name is Joseph A. Beirne, and I am the international president, Communications Workers of America. This organization, which I am privileged to serve as president, represents over 300,000 workers in almost every skill level within the communications industry. With me at the witness table is William Dunn, my assistant, and Mrs. Sylvia Gottlieb, the research director of the Communications Workers of America.

We understand the primary purpose of these hearings is to ferret out facts surrounding the nationwide problem of automation, with particular emphasis on effects of automatic processes on employment levels. Many qualified people have already presented material dealing with the overall problem. Others have discussed with you problems within certain industries. We will confine our remarks to a description of what has happened and what is happening in the telephone industry, with particular emphasis on that portion of the industry known as the Bell System.

The Bell System, as you may know, is composed, among other things, of 21 operating telephone companies, the long-lines department of the American Telephone & Telegraph Co., the Western Electric Co., which is the manufacturing subsidiary, and Bell Laboratories. This system's primary function is to furnish local and long-distance telephone service. When we talk about the Bell System in the United States we are, in effect, talking about practically the entire telephone industry. It is estimated that the Bell System provides approximately 90 percent of telephone service in the United States as measured by annual gross revenues. The remaining 10 percent is shared by some 5,000 independent telephone companies.

It is our considered judgment that employment levels and job opportunities in the Bell System are more significant than those in any other single company in the United States. The Bell System, with its 578,436 operating employees, as of the end of 1954, is the largest single private employer of labor in the United States. In addition, the system employs another 100,000 people in the Western Electric and Bell Laboratories subsidiaries. The employment of these 100,000 people bears directly on employment levels in the operating portion of the system since they perform the research, manufacturing, distribution, and installation of telephone equipment. Except for the United States Government, no employer controls the destinies of as many workers as does this single corporation known as the Bell System.

Approximately 1 out of every 62 nonagricultural and nongovernmental civilian workers in the United States is a Bell System worker. As of December 1954, there were 685,944 Bell System employees, and 42,269,000 nonagricultural, nongovernmental civilian workers.

Moreover, these workers are found in almost every community throughout the Nation. It must of necessity follow, because of the size and the geographical scope of this large corporation, that employment levels in this single company will have some effect upon employment levels in the communities in which this company operates and ultimately upon the Nation as a whole. Employment levels in the Bell System are also sensitive barometers of this country's general economic activity since telephone business and employment levels reflect overall business fluctuations.

On charts which are attached to the statement you will be able to see what we mean when we say the Bell System is a sensitive barometer. As you look back into the history of what happened in the United States and compare it with the employment levels in, for example, the Western Electric Co., you will be able to trace that which happened in the history of the United States, economicwise and employmentwise.

The Communications Workers of America has always realized the importance of watching the job-opportunity situation in companies in which workers represented by CWA are employed. Union committees, working with elected union officers and specialists have from time to time reported on employment levels in the telephone industry and these reports have served as the basis for CWA policies, policies which I will outline later in this statement.

We in the telephone industry have lived with mechanization and its successor automation for many years. They have been accompanied by fear and job insecurity. They have been our constant companions and loom larger today than ever before.

We should like to state quite clearly and emphatically that we have never resisted mechanization for the sole purpose of maintaining jobs for workers we represent. Our basic attitude has been twofold:

First, that any employer, particularly one as large and as far-flung as the Bell System, has a responsibility to introduce conversion to machinery in such a way and at times that such changes will have the least possible detrimental effects upon the economy of the industry and the country.

Second, it has been our position that benefits derived from mechanization should be shared by owners of the industry, employees in the industry, and the public at large.

We feel these two basic attitudes have special merit in a Government-regulated, guaranteed fair-profit monopoly industry.

LACK OF RELIABLE DATA

Consistent with our first basic position we have attempted, from time to time, to discuss with Bell System officials their program of replacing workers by machines. It was our desire to use such information to answer the many fears expressed by CWA members and to assist us in developing intelligent, realistic collective bargaining programs. We wish we could report to you that our fears have been allayed. We wish we could report to you that this giant Bell System is as up-to-date in its labor-management relations as it claims to be in the mechanical equipment field. Unfortunately, we cannot do so.

All overtures made by the union to date to discuss, in a mature fashion, the nature and timing of anticipated equipment changes and their possible effect upon employment in the telephone industry have been categorically rebuffed. The Bell System is willing, in fact eager, to discuss with bankers, life insurance groups, and almost anyone else who will listen and not ask questions, their program for so-called progress. The line is drawn, however, squarely in front of CWA.

You will find attached to this brief, as attachments 1 through 8, an interchange of letters between me and various officials of the Bell System. The first letter was sent to A. T. & T. President Craig on April 26, 1954. It was inspired by Mr. Craig's remarks in the A. T. & T. Share Owners' Quarterly for April 1954, that there was a slowing down in the rate of growth in telephones and long-distance usage. This statement suggested to us that it was a good time to examine, once again, the employment situation in the telephone industry. Mr. Craig answered my letter via Vice President Maddox, stating that our letter was being referred to various companies having employees represented by CWA, and that the local company level was the best possible place to obtain the kind of information we were seeking. This was a familiar brushoff pattern we had come to expect from the Bell System, but undismayed we wrote again on May 7.

We emphasized that Mr. Craig and his associate, Mr. Maddox, had missed the point of our letter, and that we would try once again to explain what we were after. We pointed out that individual companies do not have overall statistics, nor do they know what the system is planning on an overall basis. We pointed out that answers to our questions required formulation of certain forecasts and estimates which had to be done on a systemwide basis or they would have no significance. We urged cooperation with the union and noted that if company officials were willing to make forecasts for stockholders and other groups, certainly they should be willing to do the same for their employees. Despite our assurances that we had no ulterior motives other than simple acquisition of basic information, and despite our expressed disturbance at this needless merry-go-round procedure, our requests availed us nothing.

There was some further interchange of letters after we noted additional remarks before a group of financial analysts giving almost exactly the kind of information in a general way that we wanted specifically. As if to rub salt into our wounds, at the end of the year President Craig made a speech before the Life Insurance Association annual convention in New York giving an overall picture of the telephone industry's future even to the extent of predicting more than 55 million Bell telephones in 1965 as compared with 43 million in use at the time.

Incidentally, A. T. & T. President Craig recently reported that the Bell System has passed the 45 million telephone mark, indicating that the estimate of 55 million by 1965 may well be a conservative one. Because of our inability to obtain data from the company, and for other reasons, we were extremely pleased to learn of these hearings and to learn that Bell System officials would be testifying. Perhaps the United States Government can succeed where we have failed. Perhaps the Bell System will take you into their confidence more readily than they do their own employees.

UNION ESTIMATES AND EVALUATION

Lacking management cooperation, we have attempted to develop our own estimates regarding employment levels in the face of shifts to automatic equipment in the telephone industry. We are blocked at almost every point by lack of adequate published data. Let us give you an example of why the union finds it very difficult to develop reliable forecasts without management cooperation.

For months we have been attempting to compile a simple tabulation showing what has happened to the number of employees in the telephone industry since 1920 as compared with the number of telephones and the number of average daily telephone conversations. We were trying to evaluate the effect of expansion in telephone business upon telephone employment during a period of intense local dial conversion. We chose 1920 as a base year since we know that only 2 percent of the Bell System's telephones were dial operated in that year, compared with current estimates of 84 percent.

It was practically impossible to compile this simple tabulation from published sources of information. In some years total Bell System figures included certain companies which were excluded in subsequent years, making any continuous series inaccurate. We finally had to write to the A. T. & T. Co. itself seeking the information. The final figures are extremely revealing.

Basically, these figures indicate that between 1920 and 1954 the number of telephones in the United States increased approximately 433 percent: 8.1 million in 1920; 43.3 million in 1954. Similarly, the number of average daily telephone conversations increased 382 percent: 33.1 million in 1920; 159.6 million in 1954. During the same time interval the number of employees in the industry increased only 152 percent: 229,000 in 1920; 578,000 in 1954. This leads us to the conclusion that employment opportunities in the telephone industry were maintained and even expanded during intensive mechanization primarily because of tremendous expansion in the Nation's economy and corresponding increases in telephone activity.

Examination of data relating to specific years gives us further insight into what could happen to telephone employment during a mechanization period minus compensating increases in telephone service.

For example, between 1929 and 1930 there was a small increase in the number of telephones: 1929, 15 million; 1930, 15.2 million; and in the number of daily telephone conversations: 1929, 64 million; 1930, 64.03 million. Despite this, there was a decrease in operating company employment to the extent of some 40,000 jobs. During the same year Western Electric employment dropped around 20,000.

That gives us some idea of what would happen if there was just a slight increase in the Nation's economy, if there was a slight increase in the telephone industry's economy, jobs go out the window with mechanization.

Also significant we think are date relating to changes between 1934 and 1936. During that time telephones increased approximately 10 percent—1934, 13.1 million, 1936, 14.4; and daily telephone conversations some 12 percent—1934, 58.1 million, 1936, 65 million; whereas employment increased only 4 percent—1934, 246,000, 1936, 256,000.

Perhaps the most important set of figures relate to the 6-year period 1929 through 1935. During that time telephones decreased 9 percent—1929, 15 million, 1935, 13.6 million—and daily telephone conversations 6 percent—1929, 64 million, 1935 60.3 million; whereas employment in the industry decreased 33 percent—1929, 359,000, 1935, 241,000.

During that same 6-year period the number of dial telephones in the Bell System increased from approximately 25 percent in 1929 to approximately 50 percent in 1935. Between 1953 and 1954, most recent data available, despite the fact that there was an increase of close to 2 million, or 4.6 percent, in the number of telephones in the Bell System—1953, 41.4 million; 1954, 43.3 million; and an increase of almost 6 million, or 3.8 percent, in the number of average daily telephone conversations—1953, 153.7 million, 1954, 159.6 million; the number of operating company employees was reduced by approximately 10,000—1953, 587,839; 1954, 578,435. During the same period of expansion in telephone business Western Electric Co. employment dropped around 8,000—1953, 106,024, 1954, 98,141.

That to us is very significant. That to us is where hearings of this kind can focus attention on some national policy, because even with the increasing business, associated with the increased activity of conversion to mechanization, we had a substantial decrease in employment, and the argument that the manufacturing part of the business picks up, as some other part of the operating part of the business goes down, is not true, for the reason that the Western Electric, which is the sole supplier of the Bell System operating companies, the Western Electric which makes all this new equipment, they too, in this some period lost 10,000 workers, due to no work being available for them.

The inescapable conclusion seems to be that the only way employment opportunities can be maintained in the Bell System in face of constant mechanization is to have tremendous increases in telephone service during corresponding periods of time. It is not enough to have large increases, tremendous increases are required. It is, of course, highly questionable whether increases comparable to those which have taken place during the past two decades can continue indefinitely. In fact, the 1953–54 data examined earlier indicate that the best we can hope for are slow and steady increases. In view of this we must be ready for some sharp decreases in telephone industry employment levels.

We have been rather disconcerted by popular use of the telephone industry as an example of how automation all by itself has the happy result of increasing employment. The last time this erroneous impression was created was last week when the head of the Census Bureau, Robert W. Burgess, appeared before this committee. According to newspaper reports he said that despite introduction of the dial system which displaced many telephone operators, the industry nearly doubled its employment between 1940 and 1950. His conclusion from this and other examples was that he did not expect development of machines to reduce the number of jobs over the long term. These kinds of results can be hoped for, in our opinion, only in a dynamic and constantly expanding economy. We think we have demonstrated, with just a few figures, that unless automation is accompanied by literally fabulous increases in utilization of the fruits of production, it must of necessity result in job displacement.

Mr. Burgess was optimistic in this respect and we sincerely hope he is correct, not only in terms of the long pull, but in terms of the short-term outlook, since in our opinion, both are equally important. It is of little comfort for any person currently unemployed to be told that 25 or 50 years hence things are going to be just wonderful. If telephone business continues to expand only at the modest 1954 rate, that is annual increases of 4.6 percent in telephones, and 3.8 percent in telephone calls, we estimate conservatively that by 1965 there will be anywhere from 100,000 to 115,000 fewer people employed by the Bell System. By that date A. T. & T. boasts the system will be 95 percent local dial. Our estimate is conservative because it is based on a constant rate of job displacement—that is 1.6 percent per year, the drop between 1953 and 1954, our prosperous years.

Senator FLANDERS. What is your definition of the term "job displacement"?

Mr. BEIRNE. By "job displacement" we mean when a worker is laid off, due to the kind of operations he performed no longer being necessary. For example——

Senator FLANDERS. Do you mean such as, throwing people out of work by putting in dial phones?

Mr. BEIRNE. That is correct.

Senator FLANDERS. And that is only 1.6 percent of the jobs per year?

Mr. BEIRNE. Using the 1-year period of 1953–54, which is a prosperous year.

Senator FLANDERS. All right. Thank you.

Mr. BEIRNE. A more realistic figure should assume an accelerated rate. Our experience indicates that job loss seems to snowball rather than proceed at a fixed rate.

We would not be surprised if there were 200,000 fewer Bell System employees by 1965 unless there are tremendous business increase compensating factors.

TELEPHONE OPERATORS

Perhaps the hardest hit single job has been and will continue to be that of telephone operator. In 1921, with approximately 3 percent of Bell telephones dial, there were 118,470 people in that single job. That year the Bell System handled approximately 1.3 billion calls per month, or around 10,640 calls per operator per month. In 1954, the latest year for which data are available, there were approximately 175,200 telephone operators in class A telephone companies in the United States. (Class A telephone companies are those having annual revenues exceeding $250,000.) These companies handled approximately 6.3 billion calls per month, or 35,800 calls per operator per month.

The peak number of operators, 182,500, was reached in 1949 and has been declining almost steadily since. Had there been no change in dial status since 1921, and assuming other factors remained constant, the industry would require approximately 589,749 operators to handle current telephone call volume, or over 3 times the number of operators actually employed. (Estimate obtained by dividing 1954 average monthly telephone calls by number of telephone calls handled per month per operator in 1921.)

Perhaps the hardest stories to tell about technological changes are ones centering around individuals rather than statistical totals. We could tell you, for example, that during the past 10 years in the single city of Milwaukee the number of operators was reduced from 3,500 to 1,000 in what, to outward appearances, was a relatively orderly manner with very few actual layoffs required and practically no transfers out of the city. But this is not the entire story. Among the thousand operators who remained on the job you will find some of the deepest problems inherent in technological change. A telephone operator who has been doing essentially the same basic operation for 30 years suddenly finds herself confronted at age 50 with the necessity to learn entirely different and more complicated work procedures. From an experienced, confident, efficient local operator, she suddenly becomes an inexperienced toll operator. Within this framework lies the real human drama of automation. With proper retraining this mature worker could become as valuable as she was formerly, and possibly more so. Her knowledge of the industry, company practices, and traditions, her loyalty, her willingness are invaluable assets. But her retraining requires more than just a mechanical, routine approach.

We know of cases where some workers have gotten sick on the steps of the new toll center; others developed various illnesses which could be traced to fear of new work operations. We have been told of mature women crying in restrooms, improperly prepared for new methods and fearful of losing their jobs or being pressured into unwanted, early retirement with inadequate pensions. The tragedy of the mature worker whose skill area suddenly disintegrates and is incorrectly retrained is profound.

We don't want to leave the impression that telephone management has been unaware of some of these problems. Reports to us indicate that some of them have been understood and genuine attempts have been made to ease the transition. However, in our opinion, not enough has been done. Certainly the same zeal and perfection which the Bell System uses in its programs relating to machinery has not been equaled in its human-relations programs. A retraining program designed for workers in their middle years who have been accustomed and, in fact, carefully instructed to do only a particular operation for as long as 30 years, must make allowances for certain psychological and emotional problems. We think the world's richest corporation, the Nation's largest single private employer, can do a better job than it has been doing to date. Once again we point out, through the medium of this hearing, that the union can be of assistance to the company in this regard and, in fact, has had to fill the vacuum in many localities when the company's retraining program was mechanically sound but humanly inadequate.

I would like to emphasize that while I am confining my remarks and my views with emphasis on the Bell System, what we say likewise applies to any company, and to any union that has these same problems.

We could cite you dramatic example after another of towns with 100 operators working 1 day, and just 30 or fewer left the next. Transferring workers from one town to another may seem at first glance a reasonable solution to a difficult problem. But let us keep in mind that such transfers may mean the uprooting of family ties and, in most cases, the very town to which the telephone operator is transferring will be cut to dial in another year, necessitating still another move.

We emphasize that so that we don't get a nomad group of workers in the United States, constantly running after that new job, because of their old job having been washed out through mechanization.

Making transfers available to displaced workers is, of course, frequently no solution at all to the problem. This is particularly true of women workers. Many women workers play a dual role, that of worker and household manager. Frequently they have still a third responsibility, that of mother. This means they are not mobile workers, because their future is tied to their family and their husbands' jobs. These additional duties generally make this type of worker responsible and dependable and we think she deserves something better than the false offer of a transfer or the unemployment market.

The young, single woman worker poses still another problem in job displacement situations. She may be tempted to accept the company's transfer offer to nearby or distant towns away from the protection of her home and parents. This, of course, has deep social implications.

We call these matters to your attention so that the statistics and general statements we are offering will not obscure the much more important problem of human beings finding their entire lives shaken up by so-called progress.

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For your specific information we are submitting as tables 9 and 10 results of dial conversion in two States, Michigan and Ohio, during the period November 1949 through December 1954. These tables show that in Michigan in exchanges where dial was introduced, employment dropped from 1,414 to 273, or just 19.3 percent of former employment level. Of these 761, or over half, were laid off; 48 were transferred to other departments in the same company, 309 were transferred and 5 pensioned. In Ohio, cutover exchanges had 612 employees before conversion and 278, or 45.4 percent, after; 189 were laid off, 127 transferred to other departments and 8 pensioned. This sort of thing is going on daily throughout the United States and its impact is being felt in every community.

Changing nature of jobs in the industry: Mechanization has also had a direct and significant effect upon the overall job structure in the telephone industry. For example in 1945, immediately prior to postwar mechanization and expansion, traffic operating employees—that is, workers handling calls—comprised 52 percent of the total labor force in class A telephone carriers. At that time the industry was approximately 65 percent local dial and 5 percent toll dial. In 1953 with local dial around 80 percent and toll dial 44 percent, and with the number of telephones and telephone calls almost doubled, the traffic operating force shrank to 41 percent of the total force. During that time professional, sales, clerical, and maintenance people increased as proportions of the total labor force.

It is extremely significant, moreover, that between 1945 and 1953 the number of operating employees increased only 24.5 percent compared with increases of 97.2 percent among professional workers, almost 100 percent among business and sales forces. 89.3 percent among clerical workers, and over 109 percent among maintenance workers. This is not peculiar, we think, to the telephone industry alone, but seems to be characteristic of shifts in the labor force in industry generally as automation advances.

WESTERN ELECTRIC CO.

The Western Electric Co. is a wholly owned subsidiary of the American Telephone & Telegraph Co. Its primary function is to manufacture telephone equipment, install and repair it. Employment over the years in this portion of the Bell System has been much more erratic than in the operating portion of the company. As you can see from attached table No. 2, which shows Western Electric Co. employment from 1920 to 1954, there have been sharp dips and rises in employment levels in this company. We are sometimes hardpressed to understand why some of the abrupt changes take place. For example, why did employment in this company double between 1935 and 1937 and then drop sharply between 1937 and 1938? We often wonder how this company accounts for almost annual substantial fluctuations in employment.

In 1947 this company's employment reached a peak of 132,927, then started dropping sharply only to start going up again until 1953, when another decline set in. As we discussed earlier, the A. T. & T. Co. is a monopoly and the Western Electric Co. provides that monopoly with practically all of its equipment. Certainly in such noncompetitive circumstances it should be possible to plan better so that a more stable labor force could be maintained.

At the very least, certainly it need not rise and fall as sharply as table No. 2 indicates. Is it that stability in labor force is not one of the primary considerations of the Western Electric Co.; that stability in labor force gives way to other pressures? To our knowledge, the company has not received tremendous customer pressure to initiate any of the automatic changes introduced. Therefore, the company could have planned shifts to mechanical equipment in such a fashion as to minimize, rather than to maximize, employment fluctuations. Frankly, we can't begin to imagine the basis for most of the company's timing on automation and they haven't yet seen fit to reveal it.

We emphasize that relationship, because here is a perfect laboratory specimen of business, a monopoly industry, supplied by a single employer, where mechanization is something that has been in the industry for years. Now, if such a beautiful laboratory specimen of industry cannot keep the dips and the rises of the employment levels on a more constant keel than they have, what, I ask you, will the general business community in America be able to do? They won't have that compatible relationship of being a noncompetitive business, and of being supplied by a single wholly owned manufacturing company.

That is why we emphasize this relationship between the A .T. & T. and the Western Electric, to point out that if such companies cannot work hard at this employment problem, and cannot find answers to keep levels of employment more even, the nationwide problem is something that will cause, and should cause, all of us real consternation.

THE NATURE OF AUTOMATION IN THE TELEPHONE INDUSTRY

Mechanization and telephone workers have worked side by side for the past 20 years. Changing from manually operated to dialing local calls has been a long and familiar procedure. Recent years, however, have witnessed the introduction of even more penetrating mechanization and the advent of what we now call automation. You are all no doubt well acquainted with socalled local-dial conversion. It has been in use for many years. Perhaps you are less familiar with some of the more complicated mechanical devices developed by the Bell System. For that reason we have attached to this brief, as exhibits, various articles and reports which describe some of the Bell System's automation devices. Briefly, they can be summarized as follows:

1. Operator-toll dialing and customer-toll dialing; that is, long distance—at present approximately 50 percent of all long-distance calls are dialed by an operator directly to a subscriber. This is known as operator-toll dial. Ultimate plans are for the subscriber to dial directly the long-distance number he is trying to reach without any intervention or assistance by an operator.

This is known as direct subscriber long-distance dialing. It exists to a limited degree and is increasing steadily. This means that anyone desiring to place a long-distance call will be able to do so without the use of an operator except for person-to-person calls, where the use of a single operator will still be required. It is our understanding that ultimately even person-to-person calls may be completely automated.

2. Automatic message accounting—an inseparable part of customer-toll dialing is mechanical equipment known as automatic message accounting machines. When you dial a toll call, this equipment records

your telephone number, the number you are calling, how long you talked, and so forth on a punched tape. A busy signal or no answer is likewise recorded. These perforated tapes are then decoded by additional machines which finally assemble, translate, sort, and summarize all billing information. As we understand it, in time, you will place a telephone call and be billed for it without personal intervention by any telephone worker. Telephone calls will soon be "100 percent pure," "untouched by human hands"—other than your own.

3. "M-4"—as you no doubt know, an intrinsic part of any telephone system is comprised of complex-wiring circuits. Bell Laboratories recently announced the introduction of a new machine designated starkly as "M-4" which puts together complex wiring circuits mechanically under the direction of punched tape, which an electronic brain reads and translates.

The picture would not be complete without reference to new electronic test sets which automatically test cables during periods of wet weather; T-type terminals that enable one-man splicing crews; Murphy test sets that enable cable splicers to designate cable pairs without the use of a helper; microwave stations that eliminate countless miles of poles, cable, wire, crossarms, and maintenance on these facilities; new types of central office equipment that virtually eliminate maintenance, automatic powerplants wherein auxiliary power supplies are cut in and out without aid of manual assistance; telephones on which customers can adjust the volume of bell ringing; that Ryan plow which lays cable mile after mile in trenches without assistance.

I have never seen this Ryan plow, but I understand it is something to observe in operation. It has a long metal finger extending down some 40 inches into the earth. It is pulled by 2 or 3 caterpillar tractors. It digs the trench, lays the telephone cable, and covers it in a single operation. The plow can lift out of the way any rock less than 40 inches in diameter. On a recent cable job in Missouri we understand a single Ryan plow laid 60 miles of cable in 4 days with a crew of less than 7 men. Can you envision how many workers this job formerly required when trenches were dug separately, cable laid, and trenches then filled in?

We have no desire to be alarmists. Quite the contrary; we point with pride and gratitude to miracles we have witnessed during our lifetime. The Bell System, since the end of World War II, has undergone possibly the largest expansion of any corporation in the history of this country. The number of telephones alone in the United States has more than doubled in the past decade. We acknowledge the fact that despite intensive mechanization of local telephone calls there are over 150 percent more people employed in the telephone industry today than there were 25 years ago.

There are, however, some very important lessons which we can learn from history and which should serve as the basis for planning the future. During the 6-year period between 1929 and 1935 a relatively small decrease in telephone service resulted in a 33-percent decrease in employment. In the single year, 1953–54, substantial increases in telephone service had the net effect of a decrease in employment. In other words, it appears that telephone employment can be maintained during increasing mechanization periods only by tremendous increases in telephone business. We think it unlikely that the kind of increases which have taken place in the last decade can continue into the future. For this reason we think we are faced in the telephone industry with constantly decreasing job opportunities.

CWA has many suggestions regarding what can be done to minimize undesirable effects of decreasing employment levels in this key industry. It has been our program for many years to seek a reduced workweek in the telephone industry not only because of the tedious and tiring nature of some of the jobs but also to spread employment opportunities at times when it was desirable to maintain rather than decrease employment levels. As a result of this year's negotiations, which incidentally are still in progress, we were able to shorten the workweek of some telephone operators.

The necessity, for example, for operators to have a shorter workweek has been intensified as equipment they handle requires more numerous simultaneous operations resulting in increased nervous tensions. Telephone operating has always been a job requiring constant attention, unrelieved concentration, and the ability to do several diverse operations at the same time. Automation has intensified and accelerated these pressures. It is our hope that as job opportunities decrease the Bell System will become more receptive to CWA's shortened workweek demands.

We likewise hope that many of our other suggestions, such as (1) improved force reduction and rehiring procedures; (2) interdepartmental and intercompany transfers, including payment of transfer expenses; (3) higher pensions and lower optional retirement age; (4) more liberal termination payments for persons who lose their jobs as a result of technological changes; (5) better and more extensive job retraining programs; (6) longer vacations; (7) greater weight given to seniority, and so forth, will meet with receptive attention in future collective bargaining.

On an overall basis, it would also contribute toward a more orderly method of meeting day-to-day automation job displacement problems if there were uniform, or more nearly uniform, wage and working condition practices throughout the Bell System. As the situation exists today, a worker may find his job nonexistent in an area where CWA has been successful in negotiating good wages and working conditions. The only job available to him on a transfer basis may be one covered by a trade-union contract, or no contract at all, and where the resulting wages and working conditions are not as good. Needless to say, the best possible solution to this disparity in wage and working conditions would be a uniform contract covering all Bell System workers instead of the present 57 varieties engendered by the A. T. & T. Co.'s refusal to admit that it controls all collective bargaining in the Bell System and A .T. & T.'s failure to abandon once and for all the fiction of separate and independent bargaining units.

We think hearings of this type are necessary and desirable. Certainly, before intelligent decisions can be made in a field as complicated as technological changes, a groundwork of fact and experience is necessary. We understand that Bell System representatives will be appearing before this committee, and we hope they will present to you the kind of facts which will give a comprehensive picture of what is taking place in the telephone industry.

We are not discouraged by management's reluctance to confide in us. We plan to keep trying. We hope to be able to prove to the Bell System that its workers, possibly more than any other single group, are interested in and have a real stake in technological changes in the telephone industry. We believe we will be able to make some sound suggestions which would benefit not only the workers we represent, but the company's investors and the ever-patient public who, in the final analysis, foots all bills in the industry.

This is possibly the best of all times to evaluate and study problems of replacing men by machines. Employment is relatively high and forecasts optimistic. The problem can be studied in an atmosphere devoid of the kind of hysteria characteristic of periods of rapidly increasing unemployment. We think preventive measures in the social and economic field, like in the field of medicine, are more effective and certainly cheaper in terms of money and human effort than curative measures. What does it really matter if it takes 30 seconds instead of only 15 to complete most long-distance calls if we gain this speed at the price of unemployment and its accompanying domestic and international human misery? Why the headlong rush into mechanization if slower movement gives us time to contemplate what we are doing and where we are headed?

Certainly we ought to be talking about the problem. These hearings are a step in that direction, and we are grateful for the opportunity to participate. We are not pessimistic about the future. This country, and indeed this planet, will meet its problems with ever-increasing abundance for its people. We think most elements in our society understand this and will show their appreciation to the past and their responsibility for the future by making human values paramount even in the age of automation.

The CHAIRMAN. Thank you very much, Mr. Beirne.

We will insert in the record at the conclusion of your testimony the letters and table that are attached to your prepared statement.

I had several questions I wanted to ask you, but your statement is so comprehensive, I believe it has covered everything that I had in mind, so I will not ask any questions.

Senator Flanders, of Vermont, will probably want to ask some questions.

Senator FLANDERS. First, Mr Chairman, I would like to say that I appreciate the invitation to be here during these hearings, particularly in view of the fact that I am not a member of this particular subcommittee.

The CHAIRMAN. Well, you are a member of the Joint Committee on the Economic Report, and it is always a pleasure to have you.

Senator FLANDERS. Thank you. This problem is one that has given me great interest and serious concern.

Now, Mr. Beirne, as I have listened to your presentation, am I correct in my assumption that you are not opposing these improvements, as such?

Mr. BEIRNE. No, sir; we are not. We welcome technological improvements. We think they will make a better life.

Senator FLANDERS. The only point at which you seem to suggest caution in this respect occurs in your last paragraph, pages 18 and 19, of your mimeographed statement where you suggest a slower move-

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ment, "to give us time to contemplate what we are doing and where we are heading." I don't see anything else in your statement——

Mr. BEIRNE. Yes. In my statement, Senator Flanders, you will also find we emphasize that timing is important. We want automation to come. It need not be slow, necessarily. We say, as an overall policy, let's look at what profit there is in having a quicker telephone connection made if it is at the price of human suffering. Timing is important.

Senator FLANDERS. The timing is important.

Mr. BEIRNE. That is correct.

Senator FLANDERS. But you are not making a plea for abandoning this mechanization process?

Mr. BEIRNE. No. If I should ever leave that impression, let me correct that with emphasis. We welcome what is now called automation. We always have welcomed it. We think it will make a better life, not only for our own people in the industry but for all people in the United States, and I hope in the whole world. We welcome it with open arms. We do say, however, here are some problems which cannot and should not be ducked, and I have given some suggestions on ways you can deal with some of the problems we are familiar with.

We say timing the introduction of these new pieces of equipment is very important. We say taking care of these problems is important.

Senator FLANDERS. Let me next say that it seems to me that you have made your case, and that the Bell System should take the examination and careful consideration of these problems as a major responsibility.

Mr. BEIRNE. That is correct.

Senator FLANDERS. With its enormous number of employees it cannot ignore the human elements, as well as the mechanical and electrical elements. I think you have made a very good case for that point of view.

The CHAIRMAN. May I suggest, Senator Flanders, that Mr. Beirne is the first witness to suggest that automation is the successor to mechanization.

Senator FLANDERS. Yes. Well, it is a broad-gage presentation he has made, sir.

Now, I was interested in what Mr. Beirne said with regard to an "erroneous impression left by the head of the Census Bureau." Do you challenge his findings outright?

Mr. BEIRNE. The newspaper article, Senator Flanders, did not carry any figures. It carried this optimistic statement that said, in effect, "Look at the telephone industry. Between 1940 and 1950 it had an expansion in mechanization and its employment went up."

Let me hasten to say that which I did not say formally in my statement, that the years 1940–50 was that period of time which I hope the United States never has to go through again. It was that period of time when we first had lend-lease, 1939–40, where there was a great increase in productivity, to get arms and equipment and aid to what later became our allies. It was the period when there was World War II, with all the misery and suffering that went with it, both abroad and at home. It was that period when the telephone habits of the United States changed, when your own telephone habits changed, when people had to use those telephones. It was that period when it was hard to get new employees.

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The labor market was dry. Employers were out raiding one another to get adequate numbers of workers to do their work, and the Bell System—let me say this in a praiseworthy fashion—being always about half a mile ahead of other employee recruitment thinking in the United States, was out in that labor market, putting people on their payroll, suffering in some places from as much as a 400 percent turnover in employment. They trained people to be telephone operators, holding on to people as much as they could so that they could give the service this Nation needed in that emergency period.

Senator FLANDERS. Let me call attention to your statement that "between 1945 and 1953, only part of which can be considered a war period, that still the operating employees increased by 24.5."

There is a point in there somewhere, I judge, where the operating employees began to decrease, but that was apparently not during that period, 1945–53?

Mr. BEIRNE. Well, this is where the operating employees increased only 24.5 percent, compared with——

Senator FLANDERS. But they did increase 24.5.

Mr. BEIRNE. In that period of time; that is correct.

Senator FLANDERS. When did they begin to decrease?

Mr. BEIRNE. Perceptibly, a steady decline began sometime in 1953.

Senator FLANDERS. I see. All right.

Now——

Mr. BEIRNE. What we tried to do, if I might interpose, Senator Flanders, what we tried to do in answering Mr. Burgess, and I might say parenthetically, Mr. Fairless of the United States Steel made a similar statement some 6 months ago in a speech in Pittsburgh, with respect——

Senator FLANDERS. With regard to the telephone company?

Mr. BEIRNE. With regard to the Telephone Co., and with regard to the period 1940–50. What I have tried to do in selecting other years, going from 1920 to 1955, taking the depression years, 1929 to 1935, is to pick those periods, and a number of them, which would suggest more significantly, let us say, normal times in the United States.

Senator FLANDERS. It seems to me that, on page 10, you have again called attention in the retraining matter and a lack of sufficient attention on the part of the Telephone Co. to its human responsibilities.

Mr. BEIRNE. That is correct.

Senator FLANDERS. I note your criticism of A. T. & T. as a monopoly, and your suggestion that being a monopoly—and I don't see how it can be anything else——

Mr. BEIRNE. Neither do I.

Senator FLANDERS. It has got to be a monopoly. But as a monopoly you contend that it has a very favorable possibility of evening out its employment.

Mr. BEIRNE. That is correct.

Senator FLANDERS. A possibility that other organizations, not natural monopolies, do not have.

The CHAIRMAN. Its competitor, Western Union, is also a monopoly, Senator Flanders.

Senator FLANDERS. Yes, it is a monopoly, since the Postal Union went out of existence.

The CHAIRMAN It was a hundred percent, more so than A. T. & T.

Mr. BEIRNE. Yes; more than A. T. & T.

(See letter, p. 600.)

The CHAIRMAN. A. T. & T. is only 90 percent, according to Mr. Beirne's statement. I say only 90 percent. I could leave out the "only."

Senator FLANDERS. There is competition with Western Union in its cables and radio service, but not domestic; is that right?

The CHAIRMAN. I couldn't answer you. I just don't know.

Senator FLANDERS. Although access to the cable and radio is through Western Union, through Texarkana, and likewise, Springfield, Vt.

Now, you speak of the desirability, not merely from spreading work but of the intense concentration required of not maintaining long hours. Can you tell us what the hours of the local operator in nondial exchanges are, what hours are in general, as well as what the hours of the long-distance operators are?

Mr. BEIRNE. The hours of both are the same. We have negotiated the hours a person works, based upon what time of day he works. As you readily understand, we are a 7-day-a-week business, 24 hours a day. Operators during the day work a 40-hour week, 8 hours a day, 5 days a week. They are called day operators.

Now we have such things as split shifts. Peak loads come at 10 to 3 oclock in the afternoon, here in Washington, let's say. We have women who work split shifts who may work but 7½ hours a day. We also have evening and night tours. We have in a number of places negotiated 7-hour tours where they used to be longer. That, in a general picture, are our traffic operating hours.

For plant men it is a straight 8 hours a day, 5 days a week.

Senator FLANDERS. I note also near the end of your statement definite suggestions. It is always a pleasure to have a witness come up with something tangible. I won't endeavor to pass judgment on your suggestions, but simply to commend the fact that you have made them.

The CHAIRMAN. In other words, when you complain, offer a remedy.

Senator FLANDERS. That is it.

The CHAIRMAN. Thank you very much, Mr. Beirne.

Did you want to ask any questions, Mr. Moore?

Mr. MOORE. No, sir.

The CHAIRMAN. Mr. Ensley?

Mr. ENSLEY. No, sir.

The CHAIRMAN. Thank you very much.

Mr. BEIRNE. Thank you, sir.

(The information previously referred to follows:)

ATTACHMENT 1

APRIL 26, 1954.

Mr. CLEO CRAIG,
President, American Telephone & Telegraph Co.,
New York, N. Y.

DEAR MR. CRAIG: We read with considerable concern your remarks contained in A. T. & T. Co. Share Owners' Quarterly of April 1954 to the effect that there is currently a slowing down in the rate of growth in telephones and long distance usage. Moreover, an examination of recent telephone industry employment data generally and Bell System data particularly suggests to us that now may be the best time to examine carefully the employment situation in the telephone industry. While 1953 telephone industry and Bell System employment were above 1952, the rate of increase was substantially below that of recent years. Moreover, 1954 data so far available indicates reduced overall telephone industry employment compared with the last quarter of 1953.

We do not regard decreased job opportunities in the telephone industry as desirable or unavoidable. We know that you must share our concern over the entire downward direction of economic activity in this country. Because of this, we are sure that you must have given considerable though to telephone industry employment prospects in 1954 and 1955. We would appreciate knowing what your forecasts are and what plans, if any, the system has for maintaining telephone industry job opportunities. We would like to know what your best forecast is for employment opportunities during the current year and in 1955, in the Bell System as a whole and separately in the associated operating companies, the Western Electric Co. and Bell Laboratories.

Job security for workers presently employed in the telephone industry and job opportunities for new workers as they are added to the labor force are matters of mutaul concern to management and elected representatives of telephone workers. We hope that you will give our request the serious consideration which this important subject merits.

Very truly yours,

J. A. BEIRNE, *President.*

ATTACHMENT 2

AMERICAN TELEPHONE & TELEGRAPH CO.,
New York 7, N. Y., May 3, 1954.

Mr. J. A. BEIRNE,
President, Communications Workers of America,
Washington 9, D. C.

DEAR MR. BEIRNE: This is in reply to your letter of April 26 to Mr. Craig regarding employment opportunities in the associated operating companies, the Western Electric Co. and the Bell Telephone Laboratories.

The information in which you are interested depends upon conditions in the various companies, and since they are in the best position to appraise the situation on a local basis, you may wish to contact them directly.

I am sending a copy of your letter of April 26 to the long lines department and the associated companies having employees represented by CWA.

Very truly yours,

H. R. MADDOX, *Vice President.*

ATTACHMENT 3

MAY 7, 1954.

Mr. CLEO CRAIG,
President, American Telephone & Telegraph Co.,
New York, N. Y.

DEAR MR. CRAIG: This is further in connection with my letter to you dated April 26, 1954. Mr. Maddox replied to me on May 3 and has completely missed the point and significance of my inquiry to you.

We are concerned with the overall employment situation in the Bell System. We know that A. T. & T. is in a position to give us the kinds of data and forecasts necessary to evaluate present and future systemwide job opportunities and job security. Only A. T. & T. maintains a staff whose major functions are to assist associated companies in all phases of telephone business, among which technological planning and employment policies are but a few.

Certainly, if you were willing to forecast business conditions for the comfort and security of company stockholders on an overall basis, you should not shrink from the equal responsibility of describing employment conditions for the comfort and security of telephone workers.

Separate employment data from individual associated Bell companies where CWA has contracts is not what we are seeking. We are interested in the employment data collected by the Bell System and the results of the analysis made therefrom. The people responsible for furnishing employment forecasts to the several associated companies should have such material easily available. Individual associated companies have no way of knowing what advice or assistance A. T. & T. will be offering them in connection with the increasingly important problem of telephone industry job opportunities.

In writing to you we are attempting to obtain the broadest and most reliable type of data. Such data extend beyond mere bargaining units represented by CWA. Employment situations throughout the Bell System must of necessity have their effect on CWA bargaining units.

We sincerely hope that the initial lighthanded manner in which you have treated our request does not reflect the degree of seriousness with which you regard employment problems in the Bell System.

We would like to request once again from you what your employment forecasts are and what plans, if any, the system has for maintaining telephone industry job opportunities.

Very truly yours,

J. A. BEIRNE, *President.*

ATTACHMENT 4

AMERICAN TELEPHONE & TELEGRAPH CO.,
New York 7, N. Y., May 21, 1954.

Mr. J. A. BEIRNE,
President, Communications Workers of America—CIO,
Washington 9, D. C.

DEAR MR. BEIRNE: This refers to your letter of May 7 to Mr. Craig relative to information on job opportunities.

The Bell System companies have always done everything in their power to provide steady employment. Unquestionably they will continue to exert their best efforts toward that objective. Conditions beyond their control and beyond the control of any telephone management necessarily affect their efforts since job opportunities are created and maintained by the users of the service. These outside influences vary in different places throughout the country.

In order to understand the current situation the differences in the territories served by the companies must be considered. That is why I suggested in my letter to you of May 3 what seems to be the best procedure for you to follow in seeking the information to which you refer. In making that suggestion I was motivated entirely by a desire to be helpful and I wish to assure you that there was no thought of treating the request in a lighthanded manner. May I refer you again to the suggestion contained in my letter to you of May 3.

Sincerely,

H. R. MADDOX, *Vice President.*

ATTACHMENT 5

JUNE 7, 1954.

Mr. CLEO CRAIG,
President, American Telephone & Telegraph Co.,
New York 7, N. Y.

DEAR MR. CRAIG: Let me try once again to explain to you why we consider it appropriate that our request for overall Bell System employment forecasts be directed to you as president of the A. T. & T. Co. rather than to presidents of individual associated Bell System companies. The A. T. & T. Co. has made commitments and it has the duty and responsibility under license agreements with subsidiary Bell System companies to furnish "active assistance, cooperation, and support in connection with the adoption from time to time by the licensee of such measures as will, in the judgment of the parties hereto, best protect and preserve the health and promote the well-being in employment of the employees of the licensee, and in other ways, conserve the high quality of its service to the public through the *maintenance of a stable, contented, and efficient personnel.*" [Our emphasis.] Appropriate departments or sections of the A. T. & T. Co. must of necessity be collecting and studying overall Bell System employment information and data relating to past, current, and anticipated job opportunities in the system.

As Mr. W. C. Bolenius, then A. T. & T. vice president in charge of personnel, testified in 1950 before the United States Senate Subcommittee on Labor-Management Relations in the Bell System, "* * * The A. T. & T. staff is maintained for the purpose of continuous study and improvement of all phases of the telephone business. It is, therefore, continually furnishing the companies information concerning new and better methods of providing service. It is available for consultation at any time, and it endeavors to keep each company informed of what goes on elsewhere in all phases of the telephone business—engineering, traffic, commercial, *including such matters as labor relations*." [Our emphasis.] (P. 530.)

Surely, Mr. Craig, you realize that what happens to employment in the telephone industry does not depend only upon the factors outlined in Mr. Maddox' letter of May 21. While there may be some conditions beyond direct control of the A. T. & T. Co. which affect job opportunities in the Bell System, there are many factors directly under the control of A. T. & T. which vitally affect employment levels in the Bell System. Overall local and toll dialing programing, automatic message accounting, reduction of routine maintenance, rate of new construction, scheduling of maintenance or improvement repairs and numerous other internal matters have an immediate, direct, and substantial influence on Bell System employment.

If the A. T. & T. Co. is in fact earning its license fees, and we have no reason to believe that it is not, specialized A. T. & T. staff must have at their fingertips not only a current comprehensive picture of employment in the Bell System, but sound estimates of future possibilities based not only on the general economic picture in the country but based equally importantly on internal Bell System plans. The same information we are requesting must certainly have been made available for actuarial purposes in determining pension fund requirements as well as local and long distance rate requirements.

As you well know, CWA does not represent all of the workers in all associated telephone companies. Based on experience we know in advance that a request for overall companywide employment estimates to some companies would be met with either a completely negative response lightly informing us that we do not represent any of the workers in that company or with only partial information with a polite reminder that we represent only part of the workers in that company. During periods of reduced employment opportunities many telephone workers may, of necessity, have to transfer into companies not represented for collective-bargaining purposes by CWA. Surely if we are to fulfill our role as collective-bargaining agent for the workers we do represent we must have information regarding not only those departments or companies with whom we have collective-bargaining relations, but we must have overall Bell Systemwide information. The matter of separate legal corporations and bargaining units is not relevant to our request.

We know from remarks of high management A. T. & T. officials that there is a central staff in the A. T. & T. Co., which coordinates overall Bell System data. In the words of Mr. Mark Sullivan, president of the Pacific Telephone & Telegraph Co., also testifying before the Senate subcommittee: "Along with this decentralization, there must be a certain amount of coordination and there is a central staff to do, once for all, methods and development work which can be done best at a central location" (p. 339). Continuing Mr. Sullivan's own words: "We receive the benefit of the expert and specialized knowledge, the broad and seasoned experience, of the personnel of this staff, as well as the benefit of their judgment and experience developed through their continuous and close contact with the problems, work, and results of the associated companies throughout the Nation" (p. 340).

The benefit of this judgment and experience, expert and specialized knowledge, broad and seasoned experience, is precisely what we are soliciting on behalf of the more than 300,000 telephone workers represented by CWA.

Your reluctance to provide us, from a central source, your best judgments regarding employment potentials in the Bell System is a clear violation, in our opinion, not only of your responsibilities as president of the A. T. & T. Co., but more seriously your responsibilities as a citizen in a free economy which can only survive if both labor and management realize their areas of mutuality. We cannot help but wonder at your willingness to communicate industry forecasts from a central source to A. T. & T. stockholders and the public, and your reluctance to provide the same important service to your employees through the union which more than 50 percent of them have elected to represent them. We are deeply disturbed by this merry-go-round procedure in which we find ourselves. All we are after is some reliable and seasoned judgments and data on which they are based, regarding employment outlook of this country's largest single private employer.

This request does not cloak some devious or ulterior motive. We sense the beginnings of genuine concern among telephone workers about the future of their jobs. We can give them no reliable answer without first obtaining from you, in our opinion the only logical source for such information, your estimates regarding the future.

So once again, Mr. Craig, we direct this request to your attention underlining the sincerity and gravity of our request.

Very truly yours,

J. A. BEIRNE, *President*.

ATTACHMENT 6

AMERICAN TELEPHONE & TELEGRAPH CO.,
New York, N. Y., July 7, 1954.

Mr. J. A. BEIRNE,
President, Communications Workers of America,
Washington, D. C.

DEAR MR. BEIRNE: This is in reply to your most recent letter to Mr. Craig concerning information on job opportunities.

As pointed out previously, there are several factors which can influence employment opportunities, but in the final analysis all of these are usually associated with the level of business in general and of the industry in question.

This has been true in the past with respect to the telephone business and as the general economy of the country changes it is reasonable to believe that our business will follow a similar trend. During the first quarter of 1954 the increase in our business was substantially less than the first quarter of 1953, but the results for the second quarter may show an improvement over the same period last year.

The sales programs instituted by the companies no doubt have had a favorable effect on the second quarter results and it is expected that the advantages of toll service will continue to be emphasized along with programs designed to interest the customer in new types of service and equipment.

The situation by companies, however, can vary depending upon conditions in their respective sections of the country and they are really the only source for current information on job opportunities. I am sorry that you do not seem to appreciate from our previous correspondence that the several companies are the only ones that can appraise the situation on a local basis, and to be of value it is necessary that it come from that source.

Sincerely,

H. R. MADDOX, *Vice President*.

ATTACHMENT 7

NOVEMBER 15, 1954.

Mr. H. R. MADDOX,
Vice President, American Telephone & Telegraph Co.,
New York 7, N. Y.

DEAR MR. MADDOX: We have been giving consideration to your last letter to us concerning American Telephone & Telegraph Co.'s inability to provide us with overall information on current and future employment levels in the Bell System. We are reluctant to pursue a course of correspondence with you on this subject in view of the absence of genuine cooperation on your part. However, we feel we must point out the inconsistency between the position taken in your May 21 and July 7 letters and the recent position taken by John J. Scanlon, treasurer of the American Telephone & Telegraph Co., before a meeting of financial analysts in Philadelphia on November 4, 1954.

During the course of his remarks, Mr. Scanlon discussed economic indicators which point toward an increase not only in the number of telephones but in the amount of their usage. He even went so far as to estimate the number of telephone increase during the next decade. This kind of information coupled with overall Bell System technological plan and other data can serve as the basis for reliable forecasting of job opportunities in the telephone industry.

We consider it extremely significant that, from a labor-management standpoint, you refer us to associated Bell companies which you say are the only ones who can appraise the situation in such a manner as to come up with the kind of information which will be valuable to us. On the other hand, the Bell System seems quite willing and eager, from a financial standpoint, to present an overall evaluation of the situation before a group of people whose interest and equity in the system can in no way compare with the interest and equity of the over 300,000 workers represented by CWA.

Perhaps at the time you answered our last letter you were unaware of the availability of the kind of data which Mr. Scanlon must have had before him to make the estimates that he did at the Philadelphia meeting. Perhaps you would like the opportunity to consult with him and to give a new and current look at the questions contained in our July 7 letter. Basically, what we are after, from a central source, are the best judgments regarding employment potentials in the Bell System within the next 5 or 10 years. We regard your evasive referral of our questions to local Bell companies as unnecessary time- and effort-consuming procedures. We feel that employees in the telephone industry are entitled to the same consideration and courtesy which you are providing other groups interested in telephone business.

We certainly hope that this letter will bear more fruit than our previous attempts to determine whether or not the genuine concern among telephone workers about the future of their jobs is warranted.

Very truly yours,

J. A. BEIRNE, *President.*

ATTACHMENT 8

AMERICAN TELEPHONE & TELEGRAPH CO.,
New York 7, N. Y., December 22, 1954.

Mr. J. A. BEIRNE,
President, Communications Workers of America,
Washington 9, D. C.

DEAR MR. BEIRNE: In replying to your most recent letter concerning information on future employment, I can only say again what I have said previously, that any reliable forecasting of job opportunities must necessarily come from the individual companies.

There have been marked differences in the past in the rates of growth of telephone service among the respective areas because of population migrations, economic factors, etc. There is every reason to believe that similar differences are to be expected in the future. In referring you to the individual operating companies we are suggesting that you go to the same source to which any of us would go for reliable forecasts of job opportunities.

Sincerely,

H. R. MADDOX, *Vice President.*

ATTACHMENT 9

[Source: Cincinnati Telephone Bulletin, September 1955]

AN INTERVIEW ON CAMA (CENTRALIZED AUTOMATIC MESSAGE ACCOUNTING)

WHAT WILL CAMA DO?

The installation of centralized automatic message accounting equipment (CAMA), will enable our subscribers to dial directly to both nearby and distant points. It will not be necessary to have an operator complete the call or manually prepare a charge ticket.

WHY ARE WE PLANNING FOR CAMA?

The need for the introduction of customer dialing of distant calls is as apparent to us now as was the need for dial operation of our local services in the 1930's. As you probably know, if our local services were still manually handled, not only would the costs be prohibitively high, but most important, our requirements for operators would be so large that the labor market could not supply our needs. These same factors now indicate the necessity for customer dialing of distant calls at the earliest practicable date.

WHEN WILL WE HAVE IT?

The initial installation is scheduled for cutover in May 1956. At this time, our customers will be able to dial 2 letters and 5 numerals (HACD) home-area-customer-dialed calls to all offices in the southwestern Ohio numbering plan area which are on a 2-letter-plus-5-number basis. This will include such points as the offices of our company's operating area, plus Harrison, Ohio, Consolidated Telephone Co. offices in Kentucky, and the Ohio Bell Telephone Co. offices in Springfield, Xenia, and Middletown. We are now planning for a first addition for completion in 1957, which will permit our customers in Hamilton, Batavia, and Williamstown to direct distance dial to the same points and to include Dayton, Ohio, as a dialable point. The next step, possibly in 1958 or 1959, will be to add foreign area (FACD) dialing to Columbus, Toledo, Detroit, Chicago, Cleveland, Indianapolis, Pittsburgh, and perhaps others, to our customers' dialing range.

WHAT IS THE ESTIMATED COST?

The latest estimate of the initial installation cost will be in the order of $800,000.

HOW WILL A CALL BE HANDLED BY THE CAMA EQUIPMENT?

Assume a Jackson subscriber, say JA 1–9990, wishes to reach a number in Hamilton, say TWinbrook 4–9960. He would dial the 2-letter and 5-numeral Hamilton number in the same manner as a local call. After dialing is completed, an operator at the CAMA equipment will be automatically connected to the circuit and will say to the originating subscriber, "What is your number, please?" Upon obtaining the calling number (JA 1–9990) from the customer, the operator will record this number in the CAMA office machinery by registering it on a key set located before her. The operator will then be released from the connection and the equipment will automatically complete the call and ring the Hamilton telephone number that was dialed by the customer (TW 4–9960). When the Hamilton subscriber answers the call, the automatic equipment in the CAMA office will make a record of the call, including the time of conversation and charge information from which the monthly bills will be prepared. If the call is not completed because the Hamilton number was busy or did not answer, the automatic equipment will recognize this and no charge for the call will be made. The only apparent difference to the customer between this type of call and a local call will be the momentary intervention of the operator to identify the calling number.

WILL CAMA IMPROVE OUR SERVICE TO OUR CUSTOMERS?

The economies, improvement in speed of service, and other advantages derived from customer dialing of local calls as against operator handling are well known. These same advantages will be derived from customer dialing of distant calls.

WHO WILL OPERATE CAMA?

The traffic department will operate the CAMA switchboard positions used for operator identification of the calling subscriber's number. The accounting department will operate the automatic message accounting equipment which will prepare the customer's toll statements for billing. The plant department will maintain all of the equipment.

WHERE WILL THE CENTER BE LOCATED?

All of the equipment will be installed in the 209 West Seventh Street building. The CAMA switchboard positions will be in the operating room on the fifth floor. The CAMA crossbar tandem and the AMA accounting center equipment will be on the fourth floor.

ATTACHMENT 10

[Source: Transmitter, September–October 1955 issue, p. 51]

MACHINE WITH A "BRAIN" WIRES COMPLEX APPARATUS AUTOMATICALLY

An ambidextrous machine that can automatically wire complex electrical apparatus has been developed by the Bell Telephone Laboratories.

The experimental machine, called the M–4, was developed by the laboratories to study apparatus and equipment design best suited for automation. It can neither see nor hear, but it can "feel," and thus follow instructions with great accuracy. Instructions are fed to the machine from a punched tape. A series of relays, acting as the machine's "brain," translates this information into electrical signals. The signals then control the cams and gears of the machine.

The M–4, designed by R. F. Mallina, uses a process for making solderless wrapped connections also started at Bell Laboratories. This process, applied by hand-controlled tools, is now used for important production work by the Western Electric Co. Connections are made by automatically wrapping six turns of solid-conductor wire around a rectangular terminal. The high wrapping tension provides an airtight, corrosion-resistant contact between the wire and terminal at numerous points.

Bell Laboratories tests indicate that the solderless wrapped connection could be expected to provide a satisfactory connection for at least the life of the associated apparatus.

Solderless wrapping eliminates the danger of burns from hot soldering irons. It does away with disagreeable solder fumes and the chance of short circuits from solder splashes or wire clippings.

The experimental machine uses two rotating spindles. The wire is fed directly from a large spool. One spindle pulls the wire, in an inverted L-shaped movement, to a connecting terminal. At the same time the wire is cut to the correct length at the second spindle. The spindles remove a bit of insulation from each end of the wire as they whip the bare wire ends around the terminals. This produces a pressure of about 15,000 pounds per square inch at each contacting area. Following their punched-tape instructions, the spindles then pick up the wire supply from the spool and move to the next electrical connection where the process is repeated. Machine wiring eliminates the need for preparing, storing, and handling many short pieces of wire.

The M–4 can be used in conjunction with plastic panels, all alike, on which are mounted different groups of electrical parts such as electron tubes, or transistors, resistors, and capacitators. The terminals of the parts protrude through holes in the panels spaced at regular (modular) intervals.

It can be visualized that when suitable apparatus and equipment designs are ready for manufacture, several machines developed along the lines of the M–4 might be used at once, all receiving instructions from a common "brain." The machine is a distant cousin of textile-industry machines which handle and interconnect thousands of threads more delicate than wire.

TABLE 1.—***Bell system (A. T. & T. Co. and its principal telephone subsidiaries) (excludes Cincinnati and suburban and Southern New England Telephone Cos.)***

[All figures in thousands]

	Number employees end of year	Number company telephones end of year [1]	Average daily telephone conversations			Percent toll
			Local	Toll	Total	
1920	229	8, 134	31, 818	1, 307	33, 125	3. 9
1921	222	8, 718	33, 738	1, 337	35, 075	3. 8
1922	240	9, 324	37, 052	1, 505	38, 557	3. 9
1923	268	10, 202	41, 356	1, 663	43, 019	3. 9
1924	279	11, 168	45, 520	1, 835	47, 355	3. 9
1925	293	11, 910	48, 051	2, 090	50, 141	4. 2
1926	299	12, 671	51, 230	2, 366	53, 596	4. 4
1927	304	13, 405	52, 476	2, 577	55, 053	4. 7
1928	329	14, 178	56, 084	2, 799	58, 883	4. 8
1929	359	15, 035	60, 912	3, 095	64, 007	4. 8
1930	318	15, 187	61, 150	2, 884	64, 034	4. 5
1931	289	14, 911	60, 961	2, 646	63, 607	4. 2
1932	260	13, 307	57, 460	2, 199	59, 659	3. 7
1933	245	12, 819	54, 481	2, 016	56, 497	3. 6
1934	246	13, 117	55, 912	2, 099	58, 011	3. 6
1935	241	13, 573	58, 066	2, 224	60, 290	3. 7
1936	256	14, 454	62, 485	2, 490	64, 975	3. 8
1937	268	15, 332	66, 210	2, 580	68, 790	3. 8
1938	257	15, 761	67, 400	2, 497	69, 897	3. 6
1939	260	16, 536	71, 200	2, 602	73, 802	3. 5
1940	275	17, 484	76, 560	2, 743	79, 303	3. 4
1941	314	18, 841	81, 576	3, 116	84, 692	3. 7
1942	327	20, 013	83, 466	3, 427	86, 893	3. 9
1943	343	21, 247	82, 195	3, 912	86, 107	4. 5
1944	338	21, 580	81, 826	4, 233	86, 059	4. 9
1945	387	22, 446	85, 877	4, 671	90, 548	5. 2
1946	496	25, 709	100, 401	5, 361	105, 762	5. 1
1947	524	28, 507	109, 344	5, 713	115, 057	5. 0
1948	547	31, 364	119, 406	5, 865	125, 271	4. 7
1949	516	33, 388	126, 100	5, 923	132, 023	4. 5
1950	523	35, 343	134, 870	5, 912	140, 782	4. 2
1951	551	37, 414	139, 125	6, 011	145, 136	4. 1
1952	580	39, 414	143, 231	6, 129	149, 360	4. 1
1953	588	41, 353	147, 383	6, 310	153, 693	4. 1
1954	578	43, 322	153, 041	6, 554	159, 595	4. 1
Increase, 1920–54:						
Number	349	35, 188	121, 223	5, 247	126, 470	------------
Percent	152. 4	432. 6	381. 0	401. 4	381. 8	------------

[1] Excludes private-line telephones.

Source: H. R. Maddox' letter to J. A. Beirne, Oct. 11, 1955.

TABLE 2.—***Western Electric Co. employees, 1920–54***

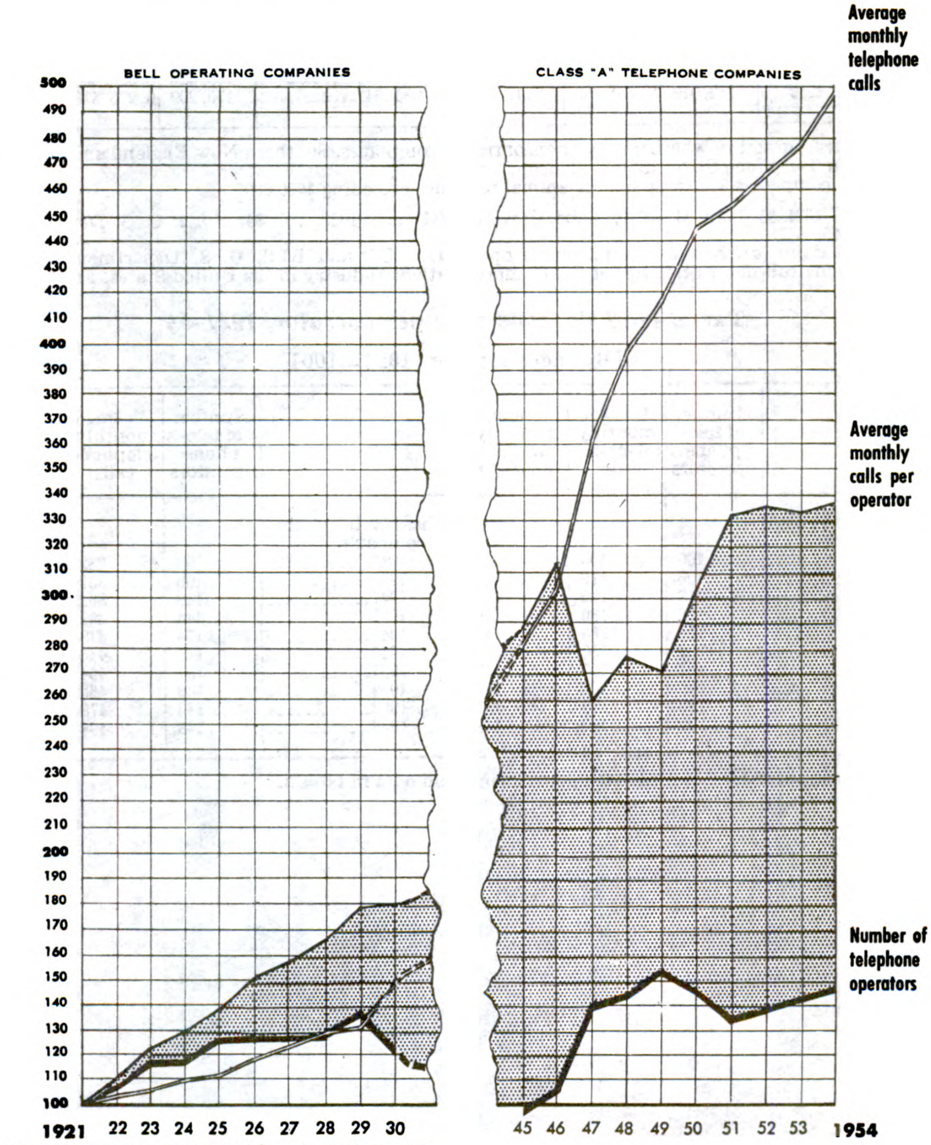
Year	Number	Index, (1920=100)	Year	Number	Index, (1920=100)
Dec. 31—			Dec. 31—		
1920	39, 650	100. 0	1938	30, 298	76. 4
1921	45, 243	114. 1	1939	32, 602	82. 2
1922	51, 162	129. 0	1940	42, 083	106. 1
1923	63, 808	160. 1	1941	61, 271	154. 5
1924	49, 157	124. 0	1942	73, 320	184. 9
1925	39, 460	99. 5	1943	89, 016	224. 5
1926	45, 110	113. 8	1944	94, 025	237. 1
1927	40, 565	102. 3	1945	80, 029	201. 8
1928	56, 324	142. 0	1946	114, 525	288. 8
1929	84, 848	214. 0	1947	132, 927	335. 2
1930	64, 253	162. 0	1948	103, 770	261. 7
1931	44, 613	112. 5	1949	72, 086	181. 8
1932	21, 270	53. 6	1950	73, 458	185. 3
1933	18, 446	46. 5	1951	90, 161	227. 4
1934	20, 416	51. 5	1952	104, 887	264. 5
1935	21, 033	53. 0	1953	106, 024	267. 4
1936	34, 004	85. 8	1954	98, 141	247. 5
1937	43, 548	109. 8			

Source: Western Electric annual reports to stockholders except for 1938 and 1939 figures; 1938—Moody's Public Utilities, 1939, p. 787; 1939—Moody's Public Utilities, 1940, p. 157.

Chart No. 1

Telephone Calls Per Operator 1921-1953

(By Index No.—1921=100)



SOURCE: Computed by CWA Research Department October 1955

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TABLE 3.—*Telephone calls per operator, 1921–54*

	Number of telephone operators	Average monthly telephone calls	Average monthly calls per operator		Number of telephone operators	Average monthly telephone calls	Average monthly calls per operator
Bell operating companies: [1]		*Thous.*		Class A telephone companies: [2]		*Thous.*	
1921	118,470	1,260,619	10,641	1945	115,547	3,550,026	30,724
1922	126,080	1,384,446	10,981	1946	125,290	4,181,559	33,375
1923	138,435	1,542,947	11,146	1947	165,461	4,568,398	27,610
1924	139,891	1,639,785	11,722	1948	170,156	5,016,126	29,480
1925	148,856	1,757,363	11,806	1949	182,501	5,264,442	28,846
1926	150,753	1,886,529	12,514	1950	174,650	5,619,212	32,174
1927	150,301	1,974,418	13,136	1951	162,053	5,730,111	35,359
1928	153,260	2,099,104	13,696	1952	165,027	5,880,298	35,632
1929	161,669	2,259,694	13,977	1953	169,680	6,020,608	35,482
1930	143,979	2,270,756	15,771	1954	175,209	6,275,516	35,817

[1] Not clear from source whether or not noncontrolled companies, Southern New England and Cincinnati & Suburban Telephone Co.'s, are included.

[2] Class A companies are those having annual revenues exceeding $250,000

Source: 1. 1921–30 data: Monthly Labor Review, February 1932, vol. 34, No. 2; U. S. Department of Labor, p. 243.

2. 1945–54 data: (*a*). Number of telephone operators, FCC and BLS, U. S. Department of Labor. (*b*). Telephone call data, Statistics of the Communications Industry in the United States, FCC, 1945–54.

TABLE 4.—*Telephone calls per operator, 1921–54*

[By index number, 1921=100]

	Number of telephone operators	Average monthly telephone calls	Average monthly calls per operator		Number of telephone operators	Average monthly telephone calls	Average monthly calls per operator
Bell operating companies:				Class A telephone companies:			
1921	100	100	100	1945	98	282	289
1922	106	110	103	1946	106	332	314
1923	117	122	105	1947	140	362	260
1924	118	130	110	1948	144	398	277
1925	126	139	111	1949	154	418	271
1926	127	150	118	1950	147	446	302
1927	127	157	123	1951	137	454	332
1928	129	166	129	1952	139	466	335
1929	136	179	131	1953	143	478	333
1930	122	180	148	1954	148	498	337

Source: Computed by CWA research department from data in table 3.

TABLE 5.—*Overall change in class A telephone carrier employment between 1945 and 1953*

Employment classified according to occupation	Number of employees, end of October—		Amount of increase between 1945 and 1953, number of employees	Percent increase in number of employees between 1945 and 1953
	1945	1953		
Officials and managerial assistants	3,595	4,627	1,032	28.7
Professional and semiprofessional	17,160	33,843	16,683	97.2
Business and sales	18,114	36,203	18,089	99.9
Clerical	64,903	122,847	57,944	89.3
Operators	207,622	258,488	50,866	24.5
Chief operators service, assistants, and instructors	28,522	36,714	8,192	28.7
Experienced operators	115,547	169,680	54,133	46.8
Trainees	58,099	49,186	−8,913	−15.3
Other	5,454	2,908	−2,546	−46.7
Construction, installation, and maintenance	68,658	143,864	75,206	109.5
Building, supplies	17,788	25,450	7,662	43.1
All other, not elsewhere classified	115	505	390	339.1
Total, all employees	397,955	625,827	227,872	57.3
Part time	18,671	19,111	440	2.4
Full time	379,284	606,716	227,432	60.0

Source: 1945 data: Statistics of the Communications Industry in the United States, issued by FCC; 1953 data: Earnings of Communications Workers, October 1953, issued by U. S. Department of Labor in cooperation with FCC, except for number of officials and managerial assistants which was obtained from Bureau of Labor Statistics.

TABLE 6.—*Class A telephone carrier employees—By types of workers, percent in each class—1945–53*

Employment classified according to occupation	Percent each class is of total, as of Oct. 31	
	1945	1953
Officials and managerial assistants	0.90	0.7
Professional and semiprofessional	4.31	5.4
Business and sales	4.55	5.8
Clerical	16.31	19.6
Operators	52.17	41.3
Chief operators, service assistants, and instructors	7.18	5.9
Experienced operators	29.04	27.1
Trainees	14.59	7.9
Other	1.37	.5
Construction, installation, maintenance	17.25	23.0
Building, supplies	4.47	4.1
All other, not elsewhere classified	.03	.1
Total all employees	100.00	100.0
Part time	4.69	3.0
Full time	95.31	97.0

Source: 1945 data, annual report, Statistics of the Communications Industry in the United States, issued by FCC; 1953 data, Earnings of Communications Workers, October 1953.

TABLE 7.—*Dial telephones—Bell System, 1921–54*

Dec. 31, year	Percent of dial telephones [1]	Dec. 31, year	Percent of dial telephones [1]	Dec. 31, year	Percent of dial telephones [1]
1920	1.9	1932	42.7	1944	64.9
1921	2.7	1933	45.9	1945	64.6
1922	3.6	1934	47.2	1946	64.3
1923	5.6	1935	48.1	1947	65.6
1924	8.7	1936	48.6	1948	68.1
1925	12.5	1937	49.8	1949	73.0
1926	15.5	1938	52.4	1950	75.5
1927	18.7	1939	55.7	1951	77.4
1928	21.8	1940	59.9	1952	79.1
1929	26.2	1941	63.3	1953	81.3
1930	31.9	1942	65.1	1954	84.0
1931	37.4	1943	65.0		

[1] Bell System data for 1936 and subsequent years consolidate the statistics of the A. T. & T. Co. and its principal telephone subsidiaries which differ from past practice in that it excludes the Southern New England and Cincinnati & Suburban Telephone Cos., which are noncontrolled, and includes certain controlled companies not heretofore included.

Source: Furnished by Accounting Compliance Branch, Telephone Division, FCC.

TABLE 8.—*Percent of dial telephones—Bell System*

Bell System companies	1939	1948	1949	1950	1951	1952	1953	1954
A. T. & T. Co	------	------	------	------	------	------	------	------
Bell of Nevada	79.3	79.1	84.3	84.3	84.4	84.8	86.1	87.0
Bell of Pennsylvania	66.8	68.9	71.4	74.3	75.9	78.6	80.2	82.5
C. & P. of District of Columbia	73.7	97.8	100.0	100.0	100.0	100.0	100.0	100.0
C. & P. of Baltimore	31.6	60.0	70.6	70.9	71.4	72.9	75.4	79.0
C. & P. of Virginia	58.1	78.6	84.3	86.3	87.4	87.4	90.5	92.4
C. & P. of West Virginia	43.6	51.0	75.0	62.2	62.2	62.3	63.3	66.8
Cincinnati & Suburban	65.6	89.5	91.1	97.5	99.3	100.0	100.0	100.0
Diamond State	89.2	94.9	98.6	100.0	100.0	100.0	100.0	100.0
Illinois Bell	29.4	51.7	62.2	68.2	70.9	74.8	77.1	79.4
Indiana Bell	52.4	73.0	77.2	79.7	81.9	82.2	82.2	84.3
Michigan Bell	78.7	82.9	85.1	87.1	87.1	89.0	90.5	92.2
Nountain States T. & T	22.6	48.2	53.2	53.2	57.0	60.5	65.5	71.2
New England T. & T	42.8	54.8	59.2	59.7	60.5	62.2	63.9	68.4
New Jersey Bell	34.1	44.0	51.6	58.1	63.3	65.8	69.5	73.5
New York Telephone	70.4	76.1	79.9	81.8	83.9	85.7	87.1	89.2
Northwestern Bell	48.6	61.6	63.1	66.6	69.3	70.8	73.1	77.6
Ohio Bell	76.8	88.7	89.3	91.6	91.7	92.9	93.0	94.0
Pacific T. & T	50.4	81.2	85.7	86.9	87.9	89.1	90.3	92.5
Southern Bell T. & T	47.5	66.0	70.1	75.0	78.2	79.6	81.6	84.1
Southern California	85.6	------	------	------	------	------	------	------
Southern New England	62.8	74.3	80.2	89.8	93.4	96.4	100.0	100.0
Southwestern Bell	60.9	65.6	70.1	70.3	71.6	73.7	78.1	80.8
Wisconsin Bell	23.6	50.1	71.6	77.9	77.8	78.1	82.3	85.0
Total [1]	55.5	68.5	73.3	76.1	77.9	79.7	81.9	84.5

Year:	*Percent toll dial*	Year—Continued	*Percent toll dial*
1939	0	1952	40
1945	5	1953	44
1951	38	1954	[2] 50

[1] Total percentage of dial phones for each year derived by dividing the total of company phones for all companies into the total of dial phones for all companies.

[2] Over 50 percent.

Source: Local dial data: Computed from data obtained from telephone company annual reports to the FCC—form No. 51 (formerly numbered form No. 400); long distance dial data: 1945, Bell Telephone magazine, summer 1945; 1951, 1952, 1953, and 1954—A. T. & T. annual reports to stockholders.

TABLE 9.—*Dial conversions—Michigan*

Date of cut-over	Name and location of exchanges	Type of conversion		Number of employees		Number of employees laid off		Number of employees transferred		Number of employees pensioned
		Local	Toll	Before cut-over	After cut-over	Temporary	Regular	To other departments	To other exchanges	
July 19, 1951	Coloma	X		9	0	2	4	0	3	0
Do	Watervliet	X		11	0	5	4	0	2	0
	Total			20	0	7	8	0	5	0
Feb. 18, 1952	Big Beaver	X		21	0	9	2	1	8	1
Feb. 21, 1952	Boyne City	X		16	0	3	9	0	4	0
Do	East Jordan	X		10	0	4	4	0	2	0
Apr. 20, 1952	Wyandotte	X		150	0	57	47	19	26	1
May 9, 1952	Lexington	X		6	0	4	2	0	0	0
June 29, 1952	Garfield	X		104	0	5	9	2	88	0
July 19, 1952	Grand Blanc	X		14	0	7	3	1	3	0
July 22, 1952	Oscoda	X		9	0	1	3	1	4	0
	Total			330	0	90	79	24	135	2
Jan. 3, 1953	Cadillac	X		63	35	14	7	0	7	0
Jan. 8, 1953	Lowell	X		17	0	2	6	0	9	0
Jan. 10, 1953	Crystal Falls	X		14	0	1	8	0	4	1
Jan. 22, 1953	Reed City	X		17	9	7	1	0	0	0
Apr. 1, 1953	Caledonia	X		4	0	1	2	0	1	0
Do	Middleville	X		6	0	1	2	1	2	0
July 28, 1953	Military establishment, Battle Creek	X		64	15	0	33	1	15	0
Aug. 20, 1953	Sault Ste. Marie	X		116	55	24	16	1	20	0
Sept. 5, 1953	Midland	X		84	0	23	42	2	17	0
Sept. 12, 1953	Lapeer	X		50	0	12	35	0	3	0
Sept. 27, 1953	Algonac	X		21	0	5	9	1	6	0
	Total			456	104	80	161	6	84	1
Jan. 24, 1954	Hillsdale	X		69	48	4	7	1	9	0
Mar. 4, 1954	Gladwin	X		14	0	4	6	0	3	1
May 16, 1954	Wayne	X		142	0	36	62	9	37	0
June 22, 1954	Fowlerville	X		10	0	0	7	0	3	0
Do	Pinckney	X		7	0	1	5	0	1	0
July 18, 1954	Monroe	X		175	62	21	64	6	22	0
Sept. 27, 1954	Beulah	X		12	0	3	8	0	1	0
	Total			429	110	69	159	16	76	1

TABLE 9.—*Dial conversions—Michigan*—Continued

Date of cut-over	Name and location of exchanges	Type of conversion		Number of employees		Number of employees laid off		Number of employees transferred		Number of employees pensioned
		Local	Toll	Before cut-over	After cut-over	Temporary	Regular	To other departments	To other exchanges	
Jan. 23, 1955	Ishpeming	X		43	0	8	33	1	1	0
Do	Negaunee	X		17	0	2	13	0	1	1
Do	Marquette	X		119	59	16	36	1	7	0
	Total			179	59	26	82	2	9	1
	Grand total			1,414	273	272	489	48	309	5

TABLE 10.—*Dial conversions—Ohio*

Date of cut-over	Name and location of exchanges	Type of conversion		Number of employees		Number of employees laid off		Number of employees transferred		Number of employees pensioned
		Local	Toll	Before cut-over	After cut-over	Temporary	Regular	To other departments	To other exchanges	
Nov. 26, 1949	Miamisburg	X		35	0		7		28	
Apr. 22, 1950	Zanesville	X		127	58	5	46		16	2
Apr. 5, 1952	Xenia	X		92	76	3	5		8	
Apr. 28, 1952	Franklin	X		23	0	3	11		9	
Nov. 22, 1952	Carroll	X		5	0		5			
Do	Rushville	X		5	0		2		3	
Do	Sugar Grove	X		5	0		4		1	
	Total			130	76	6	27		21	
Dec. 12, 1953	Fremont	X		79	78	1				
Do	Lindsey	X		5	0		5			
	Total			84	78	1	5			
May 22, 1954	Toronto	X		24	0		8		16	
Nov. 6, 1954	East Liverpool	X		175	66	8	66		33	2
Do	Wellsville	X		27	0	1	9		13	4
Dec. 18, 1954	Winchester	X		10						
	Total			236	66	9	83		62	6
	Grand total			612	278	21	168		127	8

The **Chairman**. Dr. Brunetti, we are glad to have you. Before you begin your formal presentation, Dr. Brunetti, I wonder if you could tell us a little of the story as to how a company like General Mills, which is famous for its flour and food products, suddenly turns up as the developer of Autofab, which is used, as I understand it, in the assembly of television and other electronic units.

I have been told also that you, personally, have had a great part in the development of the Dick Tracy two-way radio wristwatch, and that this development was in someway an outgrowth of your work for the Defense Department. Perhaps you will comment on that also.

Senator **Flanders**. Mr. Chairman, may I say that I am going to be exceedingly interested in this, but I do have to leave in a few minutes. I hope that my leaving will not be taken by you as any evidence of lack of interest.

The **Chairman**. We are glad to have had you the short time we have, Senator Flanders, and we shall be very glad to have you back when you can return.

STATEMENT OF CLEDO BRUNETTI, DIRECTOR, ENGINEERING RESEARCH AND DEVELOPMENT, GENERAL MILLS, INC., ACCOMPANIED BY A. A. BREVAIRE AND W. H. G. FITZGERALD

Dr. **Brunetti**. Thank you, Senator Flanders and Chairman Patman. It is really a privilege to be here and to have listened to the speech ahead of mine and to be able to come before a subcommittee of this type to discuss the topic of automation, its impact on the country, its advantages, and problems. I would like to introduce my colleagues from General Mills.

Next to me, Mr. Art. Brevaire, and Bill Fitzgerald.

Dr. **Brunetti**. Now in answer to your question I would like to explain why we at General Mills are in the automation business; first to tell you that my own experience with these problems dates back some 15 years in university, government, and industrial activity. General Mills is a company that is diversified in the food, the chemical, and the technical equipment field, and which has been built on continued use and development of better tools of manufacturing.

General Mills is in the automation business because it has a mechanical division of some 2,200 people, which was started about 25 years ago to design and build automatic and continuous food processing and packaging machinery which could not be purchased in the national market.

From this a demand developed on the outside for equipment of this general type and we set up to supply this demand. Many types of machines were designed and built at General Mills, and I won't go into the details of them. I would like to mention processing machines for new types of breakfast foods, automatic fabrication machines for making plastic bags and milk cartons, machines for making and packing flexible containers of aluminum foil, and paper for dried soups, et cetera.

Senator **Flanders**. Excuse me just a minute, Mr. Chairman.

I imagine that one of the plastic-bag applications was that of balloons over the Iron Curtain. In other words, you were in the plastic-bag business before you offered them for that purpose; is that true?

Dr. BRUNETTI. Yes; that is right. Then we got into the pillow-balloon business, and since then have made hundreds of thousands of balloons for the Crusade of Freedom, and other uses.

Senator FLANDERS. Thank you.

Dr. BRUNETTI. With that I would say General Mills has produced a large variety of other equipment, including Autofab.

I would like to point out again that in the hearings of this subcommittee to date there has been presented a lot of information on the background and need for automation in terms of the projected gross national product, the growing population, and the labor force. Our thoughts on this are included in our prepared presentation of which you have copies, but because of what has been said before, and in the interest of time, I shall skip over those parts in my presentation. In fact, if you are following my written material, I shall have to ask you to bear with me as I skip over certain paragraphs.

The CHAIRMAN. It is entirely up to you, Doctor. We will certainly be glad to listen to you as long as you want to talk.

Dr. BRUNETTI. Thank you, sir.

The CHAIRMAN. The charts in your prepared statement will go in the record with your testimony.

Dr. BRUNETTI. First, I want to point out that automation is not a revolutionary technique, but a continuation of our progress in mechanization.

Second, I would like to present a picture of the forces that make automation necessary.

Third, I would like to tell you of automation in the electronics industry, with real and specific examples of what it is doing to our job outlook.

Fourth, I would like to show that automation creates purchasing power in advance.

Fifth, to point out the benefits small business will reap.

Sixth, to describe—and I hope clearly—that full automation cannot take the country overnight.

Seventh, to treat automation from the overall employment level, but briefly, I would like to show that it is the gross national workload, rather than the gross national product, that demands automation.

Next, I would like to describe the multitude of new job opportunities which automation is bringing to our labor force, and I would like to close then with pointing out some of our problems and some of our responsibilities.

Now I will try to go through that as quickly as I can, but I would like to develop the thinking along with it.

Throughout our history it has been feared that the machine would usurp man's own prerogatives. Yet this has never happened. Man created the machine, and like the wistful puppy, it is dependent on man for guidance, nourishment, and repair. The machine cannot think alone. It "thinks" only by selection of a number of choices that man has designed into it, and a limited number of choices. Nothing in the world of electronic marvels presents any other possibility for the machine.

We faced problems but came through well the era where machines stepped in to do the manual tasks and we created more manual tasks. Today the emphasis is on equipment to guide the operation of the machines and these equipments are creating many more new jobs, requiring more brains than brawn, as well as more manual jobs.

We are moving up on the ladder of intellectual development and our men and women in the ranks of labor are moving up to meet the challenge of this development. I repeat this important concept. When we introduced machines to do manual tasks many years ago, we created more manual jobs. The equipment and machines we are using now to do mental jobs are creating more mental jobs, as well as manual.

But we cannot do it all with machines, for though machines can work and do what we design them to do, they cannot make the decisions that man can, and in many cases they cannot compete in cost with human labor today or in the future. In this highly mechanized era, it may surprise people to know that a human operator over a period of years can be much cheaper and certainly much more flexible to changing industrial production requirements than a complex piece of machinery.

Automation, a newly coined word, to describe an old, old process, has created in some minds the impression that this is not a process of natural growth. This "newness" interpretation of the word is confusing, because the word seems to set end limits on a continuous growth process. Automation cannot be said to have begun on any certain date, nor can it be said that it will end at any definite time. Automation is in truth but a phase of our continuing technological advance. It is just more of the kind of stuff which has been taking work out of work, and creating more and better jobs all the time.

Gentlemen, we had automation in this country in 1784. This book, which I hold here, by Oliver Evans, was published in 1795, and it describes an automatic flour-milling plant which was built near Philadelphia at that time.

Senator FLANDERS. Automatic what?

Dr. BRUNETTI. Flour-milling plant. This plant took the raw materials, the wheat, and turned out finished flour without being touched by human hands. The first edition of the book describing it was published in 1795.

Senator FLANDERS. What is the name of the book and the author?

Dr. BRUNETTI. It is called The Millwrights Guide, and if you want to fix the date, 1784, it may help you to know that that was 2 years before Davey Crockett was born.

Mr. MOORE. Mr. Chairman, may I ask one question?

The CHAIRMAN. Mr. Moore.

Mr. MOORE. How was that automated plant received by the public? Was its introduction resisted or welcomed?

Dr. BRUNETTI. I am sorry, I can't tell you, Mr. Moore.

Senator FLANDERS. The author was Oliver Evans, a very celebrated Philadelphian.

Dr. BRUNETTI. I would like to say, in further comment of that particular development, that through the years we have operated flour plants on an automatic basis, where just a few people would turn out many thousands of hundredweights of flour a day. This now has been going on for many, many years.

But automation, in effect, had its start in the days of the Neanderthal man, when that early ancestor learned that the animals of the forest could be subdued more effectively with a club than with his hands. As a matter of fact, he even used it for communication in convincing his wife what to do.

The point is that the desire to lessen work, to do things more quickly, effectively, and easily, came into physical being as the wheel in that time. Man invented the wheel way back in those days and the wheel was the basis for the machine.

Ultimately then man learned to make combinations of wheels and shafts and other parts into machines capable of even more complex operation. To the machine was added cheaper, more efficient, more abundant power.

Then came programing, which was telling the machine what to do. Such as using a switch to turn it on and off, but more complicated programing. Finally, control, to check the quality and quantity of machine output. Put them all together—machine, power, programing and control—and you have a definition of automation in four words, which gives you also the history of automation.

I said I would not go into detail on domestic needs. You are well acquainted with the predicted growth in population and gross national product and the labor force. Well, let me point out only one factor relating to productivity and the national economy. If production does not keep step with demand, and we have an increasing demand going on right at this moment, there will be a greater demand for the proportionately fewer goods and services available, and inflation will be the end result. By that I mean things will cost more. A cut in the purchasing power of the dollar for you, for me, for everybody, means a lessened standard of lving. Increased productivity will be the only way of controlling any such inflationary pressure. The continuous increase in national productivity has been accomplished, not by working longer, but by constantly inventing better machinery to supplement human energy with mechanical power.

Now, our international picture: Although I am here as representative of General Mills, I have another assignment as chairman of a working group of the Department of Defense on automation in electronic production. I feel it important to mention a point, again briefly, in our international picture.

We have our way of life. Other nations have theirs. If we cherish our way of life—and we do—we must be prepared to support strong leadership with a strong economy. I will mention just a couple of statistics, because I understand some of these have been mentioned before, but one of our world neighbors has made astonishing strides in the past decade or two. We are not particularly worried, but we must not be complacent.

In 1938 the Soviet machine-tool industry was producing 1,800 tools a year. In 1955 it may produce as many as 260,000 machine tools, 150 times as much. Now in the area of technical training where the long-range effects really will count, in 1956 we will graduate 27,000 engineers. The latest figures on U. S. S. R. are 50,000. We will train 50,000 technicians; the U. S. S. R., 1,600,000. Soviet aviation technicians have now been trained——

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The CHAIRMAN. I wish you would go over that again.

Senator FLANDERS. That is on page 7.

The CHAIRMAN. That is on page 7. You mean to say that we will graduate 27,000 engineers next year and Soviet Russia will graduate 50,000, and we will train only 50,000 technicians, and Russia will train 1,600,000?

Dr. BRUNETTI. Yes; these are the figures. You can find a description of them in Nation's Business for September 1953 and Aviation Week for March 1955, for the information that is available publicly. Another important point there, Mr. Patman, is the fact that training is going on in the military program. There is an intensive technological training of every military man.

The CHAIRMAN. You mean in Russia.

Dr. BRUNETTI. In Russia—this accounts for a larger growth. But, actually, no matter how this knowledge is gotten to the people, the fact remains that their technological strength is also increasing in that way.

Senator FLANDERS. You feel these statistics are approximately correct, or are they hearsay?

Dr. BRUNETTI. These are published figures as I quoted the Nation's Business for September 1953 and Aviation Week.[1]

Senator FLANDERS. Where did Nation's Business get them?

Dr. BRUNETTI. I don't know their source, sir. My reasoning back of it, Senator, is the manner in which the training is going on, including the utilization of their military program for an intensive program of training, and in that respect, the figures seem to make sense, even though they may not be precise.

The CHAIRMAN. I understand Mr. Allen Dulles has similar figures, gathered through the Central Intelligence Agency. Since you mentioned the fact that Russia is training her men in the service, as engineers and technicians, and since you know something of the defense problems here in the United States of America, what do you think about our country doing the same thing? Should we consider doing more of it?

Dr. BRUNETTI. I believe we should. I believe we should be doing more, but I don't feel that I represent the Department of Defense and would like not to make any statements that would indicate that I was speaking for them, but as a citizen——

The CHAIRMAN. As a private citizen you think it should be done?

Dr. BRUNETTI. I think it should be done because it takes such a long time, for example, to train a fighter pilot or technician to keep an airplane going. Hence, it is important that we take advantage of that. At the same time, it would help to make the attractiveness of military training considerably greater to our people and then we have them prepared in two ways, militarywise and technicalwise.

The CHAIRMAN. I can see great possibilities.

Dr. BRUNETTI. Now, what has automation brought us? Those industries that have adopted mechanized means of increasing their output have shown striking growth and the reasons for this growth are apparent. These industries have succeeded in reducing the costs of their products through technological advance, have successfully met competition, have enlarged their markets by increasing consumer purchasing power through higher wages and reduced prices, and have added to their payrolls.

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[1] See prepared testimony submitted to subcommittee.

The facts demonstrate rather clearly that reduced costs and the resultant increased demand for goods and services have continually meant a better business and increased manpower requirements. Mechanization and technological progress have resulted in the creation of vast new industries such as the automobile industry, the aircraft industry, and the telephone industry.

Automation in one form or another has been responsible for the large nationwide network of dial telephones and the vast number of new jobs created in the organization such as that we just heard about, the American Telephone & Telegraph Co.

Installation of dial equipment, far from throwing thousands of telephone operators out of work, and except for, No. 1, the 1929 depression; No. 2, the readjustments due to decreased military spending after World War II, and Korea, has actually meant a continuing increase in the number of telephones and telephone operators in the past 10 years.

I do not share the feeling that jobs in the telephone industry will go down, but more on that later.

Today, because of mechanization, the average family enjoys a standard of living of over 30 percent higher than in 1940. Home ownership is steadily increasing, with nearly 30 million families now owning their own homes, compared with half this number in 1940. Nearly 40 million families, or three-quarters of the United States total, own their own automobiles, and over 10 percent are 2-car families. I am quoting public figures here.

Yet we have untold numbers of new products which will find their way into the homes in the years to come. For while 98 percent of the homes are supplied with radio and electricity, only 68 percent have telephones, 56 percent have vacuum cleaners, 5 percent have clothes dryers, and only 3 percent have air conditioners, and no percent have this little electronic device which I want to tell you about in a little while.

To glean another view of what mechanization has done for us, let us take a look at the past and compare it with our present situation. Our present labor force is 65 million people. Suppose we were to trace back to what it might have been without any mechanization. Our country would not have turned out to be the land of opportunity and we would find the United States with a population closer to 40 million than 165 million. Our economy would be one of farming, fishing, hunting, and hand manufacture of furniture and home necessities. If you include the principal homeworker, who would certainly be working, we estimated there would be about 14 million jobs, leading to the fact that we owe some 51 million of our present jobs to mechanization of one form or another.

Now, competition forces automation. In order to establish a sound reference for considering the reason for and effects of automation, let us reexamine some fundamentals of running a business. These apply to the cobbler doing business in a small shop, as well as to the largest of companies. A manager, be he cobbler or divisional general manager, must use every resource to keep up the volume of products sold by his establishment. For every item or product he has on the market, there are competitors by the score. His most serious and difficult problem is how to keep customers coming in the door. He does this first by offering the product at the most attractive price. To this he adds the best quality he can put in the product, at the price the customer can afford can pay. This will make his product more attractive and he hopes to sell more by doing so.

Next, to keep up his volume, and hopefully increase it, he adds new lines of products, usually of the type he can sell using his present selling methods. The cobbler adds shoe laces and shoe polish. The larger organizations who can sponsor research try to develop new products. For example, color TV instead of black and white. This would be adequate, except the day when an organization had a monopoly on a new product is a matter of history. Today, even when a company comes out with a new appliance, its competitors immediately announce they will have a similar and better product soon, and expend every effort to get it out in the shortest time possible.

So we still find price the controlling item in most of our sales. Management is ever skating on the thin line of cost of its products.

To keep his prices as low as possible, our manager introduces whatever methods or practices he can to cut down costs. If he doesn't, his sales drop and his ability to keep people on his payroll drops with it. His responsibility is to sell all the products he can, and in doing so he creates work so people can have jobs.

It is not a question of choosing to or choosing not to devise and adopt new and better ways to cut costs. Business survival makes it imperative to reduce costs by increasing productive efficiency of each employee. Business has no choice. If it refuses it will soon find its markets invaded by a more progressive competitor.

I would like to consider the situation of McKeesport Tin Plate Co., of McKeesport, Pa. This company was using a hot-roll batch process to make tin plate and knew that under development at the time was a new process employing continuous cold-roll strip milling. The continuous process produced a less costly product of higher quality. The McKeesport company continued to use the hot-roll process, and over a period of years found itself moving into a situation of fewer customers and lower sales; whatever the inertia in the company was we do not know. We did talk to one of the executives of this company last week to get some of the facts, and he told us that by the time the company decided to convert to the new process its credit had dropped to where it could not finance the new equipment. As a result, the company went out of business.

As this was the leading industry in this small town you well know the effect this had on labor. If any factor can contribute to ghost towns, failure to find out about and install cost-cutting equipment, in my estimation, stands at the top.

Another example of what can happen is portrayed by a recent study of the steel and foundry industry in Italy by my former organization, Stanford Research Institute. This study was made to see why Italy couldn't compete in the world market. It was made about 3 years ago. Italy had plenty of low-priced labor. The studies showed that they were using old facilities, equipment long outmoded but still operable. The output of 80 plants in Italy could be duplicated by 3 in the United

States. By clinging to old equipment this Nation had lost its market in this product, and the jobs went with it.

Automation, in its truest sense, starts with marketing. If marketing shows that by reducing prices he can raise the volume of products sold, reach the fellow with fewer dollars to spend, but the same desire for the product as present customers, the manager goes to work on costs. Searching for new cost-cutting methods, he looks into automation. Again, in my estimation, this is the major reason why industries go to automation.

He sees that these machines may help cut costs of present production, and it all looks rosier for a while until he finds out that the investment is higher than the savings he can foresee on present volume. What does he do? First, he assures himself that he would be able to sell enough more to make the investment pay. In most cases this assurance comes through faith in the continued growth of our country. True, industry has market analyses, but there are not insured statistics to use in this prediction.

When he sees enough to look like a green light, he goes ahead. It is this kind of faith that prompts the automobile manuacturer to invest in millions of dollars of new equipment this year and next.

What does this do to industry and the worker? Let us answer this by a close look at an industry with which we are familiar, the electronics industry.

One of the subjects which is of most concern to us today stems from the statements that automation is moving in on us rapidly, that it will soon be dominating our production picture, and unless we do something fast we may plunge into a difficult economic situation.

This is based on a feeling that electronic computers will displace entire office loads of people, or that we have machines that can turn out a thousand radio sets a day—now requiring 200 people—with only 2 people, a reduction in workers of one-hundred-fold.

It has been somewhat more than amazing to those of us who are developing better tools for production to see what glories have been piled on our shoulders as to what our new developments can do. One type of machine that has been given such medals for performance is the automatic electronic assembly machine, such as the General Mills' Autofab. This development is still more or less in its infancy, for the first machines of this type were installed about a year ago, and these were entirely experimental. The first commercial machine to be sold was General Mills' Autofab delivered last March, and although it is now being used for production we are just beginning to gather statistics on its performance.

This 24-head unit—I will show you a picture of one in just a moment—was installed at a plant of the International Business Machines Corp., participating in a military-defense program, requiring large-scale production of computers. This organization had found it impossible to acquire the necessary production personnel to meet its delivery schedule, and purchased the Autofab system to enable it to meet its commitments.

Mr. Brevaire will show you the first chart I have up at your right, and at the audience's left. This chart shows the General Mills' Autofab machine, the first model. The newer models, of which we have some coming off the line now, are esthetically a little more attractive, but, nevertheless, this is the granddaddy of them, and it is now working up at IBM.

This machine turns out an electronics circuit of the type that I am holding in my hands. If you note on the back of it the printed circuit, which is copper etched, on plastic, etched in lines which do the work of wires, and, on the other side, the components that have been inserted into that board by Autofab machine. Autofab machine inserts the components only. It does not make the printed circuit board.

Now, in this machine, the plastic board that I showed you starts at the right end and moves down the machine. As it comes under each head a component is inserted such as a resistor, tube socket, or some other component. When it comes out at the other end the board has all of these components inserted into it.

In addition to that machine, it is necessary to have 2 or 3 more machines depending on the volume, to prepare the components, to fill the magazines that you see on top of the machine, the vertical part up there. Those are magazines holdings the components.

Following this machine, the next machine, which is still under development—and no one has sold such a machine yet—is a machine to automatically solder the boards. There are many semiautomatic dip-soldering machines, but there is no automatic machine yet.

I must say there is one exception. We did complete one and it is up at IBM now, and it is just beginning to be put through its first paces.

Following that there will be an automatic test device, which is very much in the development stage, and probably will be out by the end of this year, or the first part of next year.

Let me just repeat about the Autofab system. In the Autofab system, electronic components, resistors, and tube sockets are delivered manually to a machine. The machine straightens and cuts the leads, if necessary, and loads the components in the magazines. The magazines are then manually loaded on the Autofab assembly machine. The machine then inserts these components in predesignated positions on the printed circuit board.

Following this, many components, such as transformers and large coils, are attached manually, and the assembly transported to a dip soldering machine. The components are soldered, joined to the printed circuit by dipping the board into molten solder, and then the circuit is tested.

Now, let us see what part the mechanized portion plays in the whole problem of building a radio set. The next chart shows the electronic production process, and if you cannot read it, from a distance—it is not too important, just look at the colors. There is a white line down the center. To the left of that line shows the work, or the activity at the component vendor plants. At the right, in blue, or green, whichever you see it as, we have the manual labor in a modern electronics plant of tomorrow. In the yellow we have automatic assembly in the electronics plant of tomorrow. I say "tomorrow" because we have just installed the vertical part (Autofab machine), and the little square to the left of that (component "prep" machine). The other two are still in development.

Now, you see how much of the electronic assembly plant is automatized by Autofab, or any similar type of equipment. The squares in blue still represent manual labor. Now, some of them may have various devices to assist the labor to do the job better, but there is manual labor in every one of the rest of these operations.

In particular, let me repeat: First, the machine cannot buy components, cannot receive them, cannot inspect and test them nor deliver them to the production floor. It cannot even assemble components having odd shapes, such as speakers, large transformers, brackets, and the like. It isn't that technologically we couldn't have done that, but it costs a lot of money, and it takes a lot of time to do it. I will tell you more about that in a minute. Its testing ability, when we get that yellow square, the lower one at the bottom, is going to be limited to simple checks on subassemblies.

The machine cannot put in tubes, aline and test the final assembly, put in the cabinet or attach knobs, dials, and decorative effects. It does not pack the final product, does not ship it, and certainly does not market the product.

The mechanized part accounts for a small portion of the total working force. This is hardly cutting the labor force down by a factor of a hundred. This improvement in manufacturing was accomplished only after an enormous number of man-years of work, and this work had been put in not only in the development of Autofab, but the printed circuit and mechanized assembly techniques by industry, by the Government, and by other research and development organizations.

Now, I am sure you will be interested in what the overall effect of this type of automatic equipment is on jobs. First, since the lead time of such investment is measured in terms of 1 or 2 years, it permits a gradual redistribution of labor to be effective within the industry before the full impact of the particular new automatic machine is felt in production. Second, this investment creates jobs at the machine using plant, at the plant supplying components for the radio sets, and at the plants which develop and produce the machine. These act to set up a purchasing potential which contributes to absorbing an increased quantity of goods when they are finally produced.

Now, how much increase in products can be achieved? First of all, no manager would commit his company to an expensive installation if by doing it he foresaw a drop in sales. Of the companies that have come to General Mills we have found that each of them is planning for increased sales of TV, color TV, and other products. Some estimate electronic sales will go up 25 percent, some 75 percent, or more, in the next 5 years. If we used only a 15 percent increase we would still show a gain in jobs from the use of automatic equipment. The gain is proportional to the amount of products we sell, and I doubt there is anyone who believes our gross national product is not going to continue rising.

The Autofab machines will have a useful life of 5 years, after which continued technological developments will bring new improvements on them. The industry is planning on a 5-year amortization.

We chose a 50-percent increase for our example of increased products. Considering the color TV possibilities, this does not seem excessive.

Let us now go back and see what happens to jobs as this new automation equipment goes into a plant. The production of radio sets in a plant varies from 50 to 1,500 per day. There are manufacturers that make more than 1,500, but we found 400 to be a reasonable average. For this we have found the 20-head Autofab machine to be of popular interest. It will be helpful to make this analysis in terms of each million dollars in sales volume of automation equipment.

A sales volume of a million dollars of automatic machinery is roughly equivalent to the automated portion of the assembly lines, the yellow part, in 6 radio assembly plants, each producing 400 radios per day. Included in each installation are the 4 machines blocked out in yellow. For a 400-radio-per-day output, figures we got from a radio company, from several, as a matter of fact, showed that that much of the work could be done by 25 people, using manual labor and present techniques. For 6 installations, in 6 plants, this is a total of 150 people.

Let us see how these 150 people are redistributed into other manufacturing operations within the same industry. Let us face the worst thing first. We will have to relocate 150 jobs in the 6 installations. To start with, each installation requires 6 operators. For 6 installations we have created 36 new jobs. Assuming the 50 percent increase in output, we will require 75 new jobs of indirect labor—the blue part of the chart—to receive parts, manually add large parts, dials, knobs, and so forth. That makes 111 new jobs within the assembly plant itself.

Now, the assembly plant requires more components, more tubes, resistance, more cabinets, and so forth. For the 6 plants we calculated that this means a $3 million increase in manufacturing costs per year. This establishes a requirement in the component business, the orange part of the chart, alone for 180 new jobs. The reason for that is that 60 percent of the cost, manufacturing cost of a set, 60 to 70 percent, but we chose 60 percent, is purchased components. We took the figures representing the output per worker from the component plants, and the electronic component plants are one of the most highly mechanized plants we have today. We figure that 180 new jobs was a conservative estimate of the number of people it took to turn out $1.8 million worth of additional components per year.

Adding the 180 to 111, we have now created a total of 291 new jobs, with the introduction of 6 Autofab installations, which means a net increase of 141 new jobs in the electronic manufacturing business alone.

We cannot, however, rest with this conclusion until we have made provisions for retaining of the 150 people who have transferred to a new job because of our Autofab installation. Industry and labor recognize this as a responsibility, and training programs have already been instituted. Fortunately, the redistribution problem is alleviated by the normal turnover rate in the electronics industry, and to give you an example of this we talked to the personnel director of a large radio and TV company that makes military goods, as well, having a normal employment of 3,500 people. Their normal turnover per year is 450 people.

Thus, even if we sold all six installations to a single manufacturer, we would cause no separations, but only a reduction in hirings.

We have already shown that 291 new jobs have been created to offset the 150 reductions in hirings which will result from the 6 installations.

Now, to complete this discussion we must consider how we will sell the 50 percent additional product which we have produced, because of the increased capacity of the Autofab installations. You will recall that for the 6 plants this amounts to about $3 million worth of electronic merchandise at manufacturing cost. That was figured this way: I guess I didn't give you those figures. These are small sets, I am talking about; 400 a day, 250 working days, is 100,000 sets. At $10 manufacturing cost, that is $1 million worth of sets. In 6 plants we have $6 million. We have increased it by 50 percent, which means $3 million more of electronic products sold at manufacturing costs. Now, because sales and services and distribution are expensive, we estimate that this would be somewhere near 5 to 6 million dollars in sales price.

I will come back to that, but first let me tell you how we see this market for the future. I want to stress electronic merchandise, not just more of the same five-tube, a. c.-d. c. radios. Electronic merchandise will be less expensive, have better quality, and take a different form, tapping new uses in markets not now available.

For example, in 1941 the domestic radio market consisted primarily of home radios at a value of $469 million. In 1954, which was not a peak year by any means, the domestic field included not only conventional radios but merchandise in new form such as clock radios, portables, and television sets, and totaled $1,930 million, or more than four times greater than in 1941. This was in an industry which, according to prewar "radio" thinking, was "90 percent plus" saturated.

How did this large increase in sales volume and products production come to pass? First, someone in radio merchandising who didn't believe in saturation developed new product designs such as portables and clock radios, which convinced people there should be radios all over the house instead of in the living room. Today living room radios comprise 25 percent of the total. Now, TV today would not be a mass market were it not for use of automatic machinery, in kinescope, TV tube manufacturing, and component tube manufacturing. There would be a limited demand for TV sets selling at two to three thousand dollars each. Limited sale of sets would lead to limited programs on the air, which would further limit sales, and the whole TV industry could never have gotten off the ground.

We might look to the second TV set market to further our argument. A whole new market remains to be developed here. Apparently it cannot be reached with automatic Kinescope and component manufacture alone. GE is reaching for it with a set assembled semiautomatically and selling at under a hundred dollars. Recently, another smaller manufacturer, Hallicrafters, came out with one at $98, or something like that. Other manufacturers will follow, with various automatic assembly systems, including, we hope, the Autofab, and it appears to be only a matter of time until it will be reached "and saturated," but what then? How will we sell Autofab's increased production then?

We have color TV now, but unfortunately, after rosy predictions and false starts, it is not yet off the ground. With twice as many tubes, and twice as many components as black and white, color TV cost is still too high and color TV truly awaits automation. We have many such opportunities ahead of us for new markets, new electronics products, if we can only make them available at prices we can afford to pay. In other words, make them available at prices such that even if we were not earning more we could still afford to buy them, and then hopefully as our productivity increases, and we will earn more, by so doing we will be able to buy more.

Some of the other new, but still high-cost items, include the two-way mobile telephones, citizens radio, high-fidelity home-record-playing systems, more automatic electronic controls and devices within every home, such as central control of electrical appliances, automatic window and door controls, electronic air conditioning, and even radio baby sitters.

I would like to show you this example (referred to earlier in my talk) which was developed 8 years ago, as an offshoot, let me say, of our military research program. This is a portable broadcasting set. This is for use for communication between people, one to another, or for use in listening to broadcasts, or, say, listening to something like the United Nations meeting, or at this meeting; if someone had to leave the hall he could still tune in on what was being said.

The CHAIRMAN. Can you work it?

Dr. BRUNETTI. No. That is only a transmitter, Mr. Patman.

I would like to make the point this way: This is a transmitter which has 2 tubes in it, and it has 2 batteries in it, and a number of components, and it also has the microphone which you can see in the top. By speaking into it you can broadcast to a receiver which can be in some other place.

Now, this is 8 years old. Today we have in the same size package, and smaller, two-way radio telephones or broadcasting or walkie-talkies, if you want to call them that. They are not on the market. The reason they are not, they are too expensive. Today the price is too high, the quality is not good enough, and the size could be smaller. Price, quality, and size, are awaiting automatic production to open up a new market here.

Note the size of the components in that particular package. A human worker cannot physically handle components of this small size, and in this small space. Automatic methods are needed. I have a card here which shows the miniature components of radio sets that are now being developed, and I will have to pass this up so you can get a look at it.

The CHAIRMAN. May I ask you a question about this one? In practice, how far away can you contact another person with it, if you wanted to talk to him?

Dr. BRUNETTI. This particular one in itself had a range of about 300 feet, so it was for communication within a building, or from a building, say, to an automobile outside, where you had a tape recorder and wanted to record something. I might say that some of this has been used in connection with Government law-enforcing work.

The CHAIRMAN. And the only instance it would be used would be when each person would have something the size of this or smaller?

Dr. BRUNETTI. Right, and two-ways so that they could communicate with each other. With transistors, and with the small miniature components we have we could build a two-way set like that, but it is my estimate that it would probably sell for between $100 and $200 a set, particularly if you wanted something to broadcast 2 or 3 miles. If we could put that out on the market today at $10 a set, or even $10 apiece, I venture to say we could sell a few million of them for the Christmas market, but we cannot do it.

Now, I would like to return to the example of automation of jobs in electronics. Let us leave the manufacturing portion and come back to the industry as a whole, and the sales that we talked about.

We will now realize fully how the million-dollar investment in automation equipment is multiplied into jobs for people in the wholesale, retail service, and other distribution functions. I have a chart up there which I would like to ask Mr. Brevaire to show you. Note that as time goes on the nature of our jobs are changing, but here is an area where jobs are continuing to go up. This shows employment in the retail and service industries. The red line, the red column from the black line up, represents the number of jobs in the service industries, and from the black line up to the green, the top of the green, the whole length, we have the number of jobs in the retail industry. The last column is 1955. Notice how these jobs have been going up regularly, and if you add them up you will see something like 15 million jobs in that area alone of our 65 million in the United States now.

Our increased output of $3 million per product at manufacturing costs that we were talking about in our example, $500,000 for each plant, times 6 plants, amounts to about $5 or $6 million at retail prices, as we said. Now, we talked to the heads of some department stores, downtown in Minneapolis, and we learned that a person in this distribution picture sells on the average $30,000 worth of goods per year. This is for a fairly good salesman. We felt we should take that side of the picture.

Thirty thousand into $6 million worth of new products is 200 more jobs outside the manufacturing portion of the industry.

The million dollars of sales of automatic machinery on which this discussion was based has required employment at another place, namely, the engineers and men who designed and built the machine at places like General Mills, and its subcontractors; for a million dollars' worth of automatic equipment sales it requires about 130 people at General Mills and at its principal subcontractors, to fabricate the machines.

In addition to this, it requires about 60 employees in the total for the raw materials and the finished purchased parts that we buy for that million dollars' worth of sales. If we take those figures, 130 plus 60, and divide them by 5—and the reason we divide by 5 is that the machines are going to last 5 years, so we want the average continuous new employment, we divide that by 5 and come out with 38, plus 2 more continuous jobs in servicing 6 machines, and research and development. We now have 40 new continous jobs at the machine-producing plant, and its subcontractors.

To sum up our balance sheet, then, we find that the total number of continuous jobs created by General Mills' original sale of $1 million worth of Autofab equipment has created 291 new and reduced 150 old jobs in the electronics industry, has added 40 continuous jobs in the machine-producing industry, and, in addition, created 200 jobs in the distribution and retail industries.

As I mentioned before, if you feel that 50 percent is too high, although future electronic sales predictions support this, you can make the calculations on a smaller percentage. The increase in new jobs created will be roughly proportional. But it is this potentially large increase in jobs that has led people like Don Mitchell of Sylvania to become concerned about a labor shortage in the future.

Another point I must mention is that the 130 jobs at General Mills and subcontractors, and the 60 in supplying raw materials, plus more jobs in research and development, were going on 1 or 2 years before Autofab was installed in the radio plant. These jobs have created advanced purchasing potential, this type of work now represents a substantial number of jobs, and purchasing power in our country, going back to even the raw materials, supply, and the mining of the ores for the materials.

I am sorry I don't have the figures on that. I think they would make an interesting study.

Now, in the interest of time, I have prepared a statement about small business as well as big business, and I would like to just thumbnail through that quickly, without giving too much of the figures.

We got figures for this year on the total investment of a thousand plants. (This, again, was done by a magazine, Penton Publications who surveyed several thousand plants and got replies from about a thousand of them. This is published in Steel Magazine, March 28, 1955).

Almost a thousand plants replying reported that in 1955 these small businesses were going to, well, the total was going to be $350 million spent for new equipment. Of this total, $125 million was to be spent by small- and medium-size businesses, and $225 million by large businesses.

In 1956, their estimate showed that the small and medium business spending will average $225,000 and $290,000, respectively, small and medium. While the large businesses' average spending for new equipment will be $475,000.

This shows that small business is not standing by and waiting for big business to take over and run the economy from now on. In the major factor that determines the success of a small business, or, for that matter, any business under competitive conditions; namely, price, we all know that in many cases small companies can outperform the big ones. Lower overhead, greater flexibility, and more direct supervision are some of the reasons. All manufacturers, large or small, depend on a multitude of parts suppliers who are in general small, specialty manufacturers. In the electronics industry alone we have 55,000 varieties of components, and can one manufacturing company become efficient in the production of all these, let alone have the capital to set up these lines, or even what is more to have the management capability to handle all this in one big business?

Most of these components are supplied by the small companies, each specializing in its own field and doing a remarkable job in the field of low-cost production. Few, if any, of the larger companies will find it worth while to try to compete.

Now, at General Mills we found in connection with Autofab—I will try to go through this quickly—we found that there are probably some 3,000 manufacturers that would be interested in Autofab, in one way or another. From those that came to us, and we have had hundreds come to Minneapolis to look it over and to talk to us about it, we find that only 1 or 2 percent of the total electronics industry can use the large installation—the large industries represent only 1 or 2 percent of the total in the electronics industry. The volume that we expect to sell, or, let me say that the United States expects to sell, because we are not the only one in this business—as I mentioned before, competition comes in just pretty fast, and there are others trying to sell the same kind of a machine—may amount to $30 million.

If that volume is $30 million for large business, our estimate is that medium-sized business volume will also be approximatetly $30 million, the total volume of that equipment in the United States; whereas small business—and this is equipment not in the $160,000 class like we had up on the chart, but in the $15,000 class, the volume appears to be something in the neighborhood of 40 to 45 million dollars. In other words, the volume for an automatic-machine producer is greater in the small- and medium-sized businesses than it is in the large business.

That is where we are going to concentrate our attention. At this time we are developing two new kinds of machines, a Unifab and short-run Autofab, which are in what you might call the 3 to 15 thousand dollar class, partly automated, partly manual, for the small manufacture, which will boost him right along with the large manufacturer.

Now, in regard to the question that automation may take us by storm, I would like to skip over some of the paragraphs, but I feel they are quite important, and in the interest of time I should not read them, but I would like to go back to this electronics example. In the electronics industry printed circuits were first developed 15 years ago, but they gained popularity in industry only during the past 2 or 3 years. We sold a few, industry sold a few, but not very many, and the real impetus came 2 or 3 years ago, about 12 years after they were announced, by the National Bureau of Standards and Central Lab. Recent industrial acceptance of printed circuits depended upon development of suitable materials and production processes. Autofab and other similar assembly machines are all based on the use of printed circuits. It has taken at least 1,600 man-years of effort to develop printed circuit techniques and materials to their present level of performance so that they may be used in TV sets, and other electronic equipment.

I repeat, 1,600 man-years of research and development have gone into printed circuits.

The development costs which have gone into the technology of the automatic assembly system that we showed up on the chart in yellow focuses further light on why automation will not sweep the country overnight. This development had its beginning in this world about 1944, with the work of Sargrove, over in London. To date, in this country alone, some 1,200 man-years of work have gone into this development at a cost of between 12 to 15 million dollars, and see how much of it has been automated, and then ask whether you can push this so fast that you are going to take these plants overnight.

Automation will not run wild because it has its own built-in controls. First of all, as I said, it takes many man-years of work to develop this equipment, much time is involved in determining the proper machine characteristics and following up with design. Cost is high and gambling on acceptable equipment is at least as high. You have to please a lot of people before you come out with a machine that is satisfactory. If any of you have been out to sell an Autofab machine, you know you don't walk in and sell an order. It takes 6 months to a year before a company can see all the problems to place an order.

Now, speaking of automation as far as the overall employment level is concerned, I have statistics on page 32 which show how each of the industries have gone up and up, and how the electronics-machinery employment which stood at 335,000 in 1939 skyrocketed to 1,220,000 in 1953. Incidentally, so far as these kinds of statistics are concerned, if you plot out these figures of growth of employment in these industries you will find three significant times, the 1929 depression, the post-World War II, and post-Korea, where we did have drops, and I ask, is it smart or wise to plot our future in terms of these little drops, when the drops, themselves, have been going up and up, riding a curve that rides straight up in increasing jobs?

It is true that those drops do constitute an important temporal situation which must be met in order to spare the troubles of having people out of work. I wouldn't like to be put out of work, and I would not want anything to interfere with trying to save that. I have figures on employment in electronic manufacturing here on this chart which we plotted freehand last night, after listening to one of the talks yesterday, and I note that the data was taken from a limited special part of the curve—you cannot see that from where you sit, but it goes on up, and then down, up and down. These two peaks are World War II and Korea. The figures that were used yesterday were taken on this down drop, from 1953 to mid-1955. If you look at the figures published yesterday you will find that after mid-1955 the figures have gone up to an employment which stays right on that straight-line curve that has been going up for the last 20 years.

I want to use that to make an important point. First of all, though our plants have been mechanizing intensively for years and years, excluding war peaks when the increase was higher, we have actually increased jobs in the past 20 years at the rate of 1,200,000 every year. This is treated in more detail in the paper we presented before the Conference on Social Work in San Francisco last June, which we can make copies available.

Where are we today? Today we are in serious short supply, machinists, special toolmakers, machine assemblers, draftsmen, servicemen in the factories and field, and so forth. The number of machinists and toolmakers entering the field are not enough to balance those lost by retirement or death. Is it not a paradox that we have unemployment in the face of serious shortages of semiskilled and skilled professions? We have unemployment, certainly, and we don't like it. But we have always had and may always have a residual of unemployment.

I would like you to see this chart which shows the unemployment figures. At the end of 1954—incidentally, the black columns show the employment, and the yellow columns the unemployment. The employment starts from the black line and goes all the way up through the yellow.

Now, at the end of 1954, more than 60 million persons were employed in industry, agriculture, and government. Some 3 million were idle. The ratio of unemployed to civilian labor force being just over 5 percent, compared with 33 percent in 1933. You can see the height of that (yellow) compared with the total (black color). In 1952, during the Korean war, when employers with jobs went abegging, about 1,700,000 were unemployed, or 2.7 percent of our total civilian labor force. Likewise, in 1944, during World War II, when unemployment was at an all-time low, and I was working in production engineering on the VT fuse program at that time, and going all around the country to try to help boost production, industry couldn't hire enough people, and at that time we had 670,000 people unemployed. There is therefore a certain segment of our potential labor force which would not accept employment for one reason or another. These people are permanently unemployable. In fact, let us turn that employment chart upside down for a moment, and you will see that we have employed 95 to 99 percent of the labor force, and marvel that we operated at such a high efficiency, one which I am not sure of but I don't believe any other country has yet matched.

We will probably never achieve a hundred percent perfect, but we can and will try, and that is one of the things that this committee is seeking to find ways and means to do.

Now, some of our misconceptions as to the job destroying effects of automation have come about by the tendency to consider today's workload in terms of capacity of tomorrow's machines. Again, I want to apologize for going on, but I feel that I have got a good point here, and at least I want to put it across.

Certainly we would not consider doing today's work with machines we had 20 years ago. How could we ever have achieved the standard of living which we enjoy today had we retained the tools of 20 years ago? Why, then, do we assume a static workload when we consider the effects of automation on the labor force?

The example of direct distance dialing in the telephone industry has been cited and figures quoted to show that a certain under of operators will be displaced when telephone exchanges are automatized throughout the country. Note the increase in telephone conversations which has occurred in the last decade due to more economical and faster service. The figures we have are that we will make 2 billion long-distance calls this year. The introduction of direct distance dialing will do much to cut further the cost of long-distance calls, and we expect a vast increase in the number of calls.

My dad at the moment is in Europe, and I cannot call him because it costs too much. Now, this is going to happen to a lot of people. Let us cut the cost of these calls down and the service, the business will go on up, and the jobs for electronic accounting machines will go on up, and there will be many staff and service activities to be expanded, and this will certainly result in a net gain in employment.

Now, much has been said about the ease with which modern computers enable us to do calculations, accounting, bookkeeping, and supplying of data for business operations. We hear of Erma, the big computer developed by Stanford Research Institute. I used to be associate director of Stanford Research Institute. I have seen Erma, talked to the bank people about it, and all I can say it is a good thing

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for our economy that we have these machines, and can make them available.

Take, for example, in the research and development field. No mention is made of the vast increase in complexity of the problems which we are required to solve in today's technology or information derived for business management. One needs only to consider the vast amount of computer time required to design a guided missile to acknowledge this point. The computers for these applications are so complicated in themselves that a whole new series of jobs have developed from their use.

We must have operators to attend the computers, we must have computer engineers to monitor their operation and maintain them, and we must have skilled technicians who are capable of feeding problems to the computers, and we must have girls to make out the instructions for these computers, because the computers still have to be told what to do.

Now, take for example, the large 702 computer of International Business Machines, or the equivalent one of Remington Rand. These can do accounting for large loan companies today, and they do the accounting, and they do it fast, but in doing so, they provide a terrific amount of new information. It is stored right in there, in the memory, in the magnetic tapes or drums of this computer. They want to use this information. Before it was too expensive. All they have to do is get an operator to make out instructions to the computer and it feeds back all this information. The data provided by the computer must be analyzed by human beings who understand human beings and can draw the right conclusions from the data.

Thus with additional training we can upgrade the accounting clerk to an analyst, which is certainly a more stimulating and more highly rewarding position.

In the general accounting field of business machine application the employees are generally young girls who work for a short time and move on to get married or to other interests. The turnover is as high as 30 percent per year in a bank, or that type of company, and this type of labor force has been in very short supply. Banks today have a real problem in hiring enough key-punch operators. The shortage is real, and under present technological conditions, as I have been told by the top people in some of the biggest banks in the country, this demand will never be fully met. Industry then has no choice. It is forced to use new devices by competition, and it must add to its payroll the increased staff and support activities to profit by their use.

Now to see what using the capacity of tomorrow's machines with relation to today's unemployment does to our figures, let us consider the gross national product of our country. In these terms, our workload today exceeds $370 billion. I believe the latest figures published were $392 billion. This work we must do with a labor force of 65 million people. This means that each one of us in the labor force must produce about $5,700 worth of goods or services, to contribute to the gross national product of the Nation. In 1940, we had a gross national product of $101 billion and a labor force of 54 million people. Each member of the labor force were producing about $1,900 worth of goods and services. Let us go back to that time and assume that some forward-looking exponent of automation had described the machinery which we have available today, and which enables us easily to produce $5,700 per worker, per member of the labor force. Noting this effect on the 1940 workload, we would have predicted a displacement of about 36 million people. However, we must remember that the dollar was worth more at that time, so we recomputed the figures, and we come out with 18 million people. No matter how you compute it, if you had used today's equipment in terms of the 1940 workload, we could certainly have predicted a depression at that time.

Let's consider it in terms of today. Suppose we had frozen our tools at the 1940 design, and attempted to turn out today's workload. We will take tools we had in 1940 and say we are going to slow down automation, because we had automation all the way back to 1784, as you know, and we are going to now try to turn out the 1955 workload with 1940 tools. We would need a labor force of 195 million people, 3 times the available labor force in the United States today. Now, an analogous situation exists when we attempt to consider today's workload in terms of tomorrow's machinery. I won't go through that but will let you do it yourself if you are interested.

Now I would like to make a point I feel very strongly about. Although we have 65 million people employed and may add another 10 million to the labor force in the next 10 years, we should not concern ourselves about lack of jobs for the future, for automation, if allowed to grow in its normal way, will absorb all these people in better and better jobs.

I believe that automation will add 15 million new jobs in the next 10 years. Perhaps you may want a word of explanation, and if you do, I will be glad to give it to you later. I would like to go on and make my final point: We do have times when machines go into plants and there has to be a relocation of workers. We do have these problems. We do have temporary setbacks in labor, number of jobs. We know that. We have got to face that squarely and try to do something about it.

Now, industry is keenly aware of its responsibility in the integration of machines and men. Now personnel and industrial relation leaders are not standing still and letting somebody else do this, but are alert to the problem, and forward-looking industries are now developing programs to retrain their personnel in advance of any new step introducing a machine with labor-displacing potential. In fact, this has been going on for a long time, because labor costs money to hire and train, and every company has a certain amount of money invested in each worker, and no manager wants purposely to see his workers leave the company.

Now, I thought you might be interested, and I think we can tell it best by our own program: General Mills has been carrying on a retraining program for many years. We have continually introduced new and better machinery whenever it was available. New machines at General Mills have meant only reassignment of affected people to other tasks. Frequently they have gone to higher paying jobs. We have found it necessary to lay off people in the past but it has never been due to a new machine. It has been due entirely to the market.

Now, I would like to answer this question, does a laborer have to be an MIT graduate to work in the factories of the future? This redistribution of labor within the plants at General Mills is being accomplished by the following plan which we have worked out and have had in effect for many, many years. It is a program of retraining in cooperation with the Minneapolis Vocational High School, instruction by private schools, financial assistance programs for schooling and a paid apprenticeship program. Other more specialized programs have been provided by the company to train workers in the production of a new product. For example, when we went into the balloon business. Incidentally, we trained all the balloon people on company time. I am not trying to set the standard for the industry, but in our case we found that this was the way we wanted to do it.

We have also been able to train to new levels of proficiency people to assemble high precision electromechanical instruments. For example, we manufacture optical bombsights and this is quite a high-precision device.

Let us consider a detailed example of the training offered by General Mills in conjunction with the Minneapolis Vocational High School. Training courses were set up in soldering, blueprint reading, fitting gears to shafts and electromechanical inspection techniques. General Mills expert personnel served as instructors in the school. The company provides materials and specialized equipment and works with the school in recommending and designing courses. Now in this case, trainees attend on their own time, but the company provides the tuition, and also, as I said, General Mills personnel act as instructors.

Now, when necessary, accelerated courses of instruction have led to fairly amazing results at General Mills. We talk about how long it takes to convert a man to operate an automatic machine. At one time we hired several hundred unskilled people over a period of 2 to 3 years, and they were sent by the company to attend school until their skill on a machine was sufficient for them to return as a qualified precision operator.

In most cases these people were trained to work on drill presses, lathes, milling machines, gear cutters, grinders and other shop machines, in a period of 2 to 3 months. After that we could use them in production. This doesn't apply to all of those items, and gear-cutters, particularly, take a little more time, but for grinders and drill presses, lathes, and so forth, we were able to train our people in a matter of 2 or 3 months.

Now under less urgent conditions we have an arrangement with the union. We train 1 unskilled worker for each 10 expert machinists. This goes on all the time. The company pays all outside tuition and straight-time pay for half the hours they attend school.

Now let's take a look at what the future holds for our labor force. On page 39, I have listed 23 new types of jobs that have been created by automation, and this list is only a small list. I would like to see some of the technical or other magazines, personnel magazines, list some of these jobs and describe them to our workers, because we need these kind of people. Out of this list, I am just naming a few, in addition to machine operators, we have machine maintenance mechanics, component materials handlers, we have electronic technicians, which we can't ever get enough of, tool and die makers, key-punch operators, computer programers, control equipment technicians. Only 4 out of the 23 are college graduate type. You do not need a college degree to run an automation machine.

Now what reasonable plan can we follow in setting up this very necessary retraining program? It is plan economic sense that ways must be found to do this. Short-term dislocations will occur but can be minimized by advance retraining. Industry and labor unions should join forces to prepare for the changes automation is bringing.

As a member of industry, I repeat, industry and labor unions should join forces to prepare for the changes which automation is bringing because we will all depend on people and we have got to help them and bring this retraining along faster.

I should like to recommend, therefore, the following course of action: First, that the new jobs created by automation should be defined. This has not been done satisfactorily. Second, the worker must be acquainted with the nature of the new jobs. This is a function of both the industry and the labor unions. This information should be clearly presented to the employees so they can perhaps for the first time see what automation will mean to them. Third, having been acquainted with the available new jobs, it is up to the employee to provide the initiative to obtain the basic skills necessary to accomplish the job of his selection.

Fourth, the employee may learn these basic skills from a public or vocational trade school of a type already in existence, but too few available.

Our community facilities need to be expanded and reoriented to accomplish this task.

Fifth, industry must continue and in fact increase training in the operation, use, or support of the specific automatic machines which it installs.

Sixth, procedures must be set up by industry to properly evaluate the new skills which the worker now brings to his new job and reward him for his efforts.

American labor has never in the past failed to rise to the occasion to take on any new machine dreamed up by engineers and introduced by management. The unfailing adaptability of labor to change has been demonstrated again and again in the past; why should we now deprecate labor's known adaptability and tremendous capacity to take on and master these? Experience has shown that as the level of general education has risen there has been a corresponding rise in the demand for skilled jobs and a rejection of menial jobs.

As expressed by Mr. Harry Bullis, chairman of the board of our company, before the Congress of American Industry, in 1948, 7 years ago:

> Let me emphasize that we should think of a human individual not as being composed of one part which carries on physical activity and another different one which does the thinking. We must think of the individual as a unit, which both thinks and acts. Employees should not be treated merely as pickets in a fence or as cogs in a machine. They must be accepted as associates who have self-respect and self-confidence. Each should be given an opportunity to advance if he or she is willing to pay the price in intelligent hard work.

At General Mills we have always had an attitude of returning to the worker in wages his fair percentage, when in taking on a new machine he has increased productivity for the company.

In conclusion, I would like to say that our economy has been growing due to our wholesome attitude of confidence, which is evidenced by the large investment industry is making in equipment for the future, and in the attitude of the customers buying rather than hoarding, because they feel they will have jobs.

The lifeblood of a successful economy flows in the complete circle of events, which goes as follows: Automation increases productivity, which lowers prices, permitting more goods to be sold to consumers, who have a limitless desire and are also workers, whose income has been increased by automation, thus stimulating the desire for more products and increasing the need for automation.

Let us then consider automation without emotion and with objectivity, and let it assist labor, management, and Government to attain increased productivity and a higher standard of living for all in the years to come.

Thank you.

The CHAIRMAN. Well, you have given us some very helpful information, Doctor. It is moreover a very heartening statement. The information we have received before, except for the statement by Mr. Mitchell, of Sylvania, left the inescapable conclusion that we should prepare ourselves for a much shorter workweek, and that we are going to have a surplus of labor if we do not. We should likewise get ready with a retirement system that will be much lower than the present age, and make other adjustments in order to be ready by 1965.

Your statement indicates that, while we will just be probably well on the road to this automation by that time, we will probably not need a shorter workweek. I see in your statement, some of the inferences that were left by Mr. Mitchell, namely that we will probably even have a shortage of labor. Is that the inference you want to leave, Dr. Brunetti?

Dr. BRUNETTI. Yes; it is, Mr. Patman.

The CHAIRMAN. We will probably have a shortage of labor 10 years from now?

Dr. BRUNETTI. I would like to say that my workweek runs 80 hours a week, or maybe a hundred, such as yours probably does, and in management, it seems the workweek is going in the wrong direction. If anybody could find a way to cut that down, I would sure appreciate it.

The CHAIRMAN. Yes, sir; I will join you in that.

The workweek now is about 40, and most of the witnesses predicted—in fact, all of them except one—that we had just as well get ready for a 30-hour week, or a 35-hour week. If you were to make a prediction for 10 years hence, what would be your prediction?

Dr. BRUNETTI. As to the ability of the 40-hour workweek to meet our load, our gross national workload?

The CHAIRMAN. Yes, sir; to meet the needs of the people.

Dr. BRUNETTI. I would say this is a function of how much we automate, sir, in other words, how much we continue to add automation to increase productivity. Remember, again, you can talk about doing it fast but it takes a long time to get it developed and out.

Remember that our increased standard of living is not brought to us by higher prices and subsequent higher wages. It is brought to us by more output per person, and therefore the only way you can get it is to take the labor force, multiplied by a factor which is proportional to the amount of tools you give your labor and the total will come out to be your gross national product. For example, it is around $5,700 this year. If you multiply that by 65 million employees, you come out with $370 million, or so, of gross national workload, so that with new products waiting to come out and automation waiting to make them, it is my feeling that there will be so many more products needed that the labor force will not be sufficient to take care of the job.

Now, how much it will be insufficient, I don't know, or whether we can dispense with having these extra products and still maintain a 40-hour workweek, I don't know. I am not anxious to see our workweek enlarged. I would rather see it shortened, if economically it could stand it. I don't feel, however, that I am enough of an authority or economist at this point to make a prediction on actual numbers of hours.

The CHAIRMAN. In connection with your statement that it takes so long to perfect these things that we are working on, I was told during World War II, or after World War II, that we didn't have the use of a single plane during that war that was not on the drawing board before the war started.

Was that statement correct or not? Of course, we can talk about it now, I guess. During the war it probably would have been classified information.

Dr. BRUNETTI. Mr. Fitzgerald, would you care to answer that?

Mr. FITZGERALD. All right.

Dr. BRUNETTI. He did make a suggestion I thought was rather interesting.

Mr. FITZGERALD. There were 1 or 2 designs which were on the board the first part of the war, and were in production by the end of the war.

The CHAIRMAN. I didn't understand you, sir.

Mr. FITZGERALD. There were 1 or 2 designs which were not on the boards before the war, the first part of the war, which were in production at the end of the war.

The CHAIRMAN. Before the end of the war?

Mr. FITZGERALD. Before the end of the war.

The CHAIRMAN. Before 1945, but all except the two were on the drawing board before the war started?

Mr. FITZGERALD. Yes.

Mr. BRUNETTI. I am familiar with the proximity fuse program, which had already started and which has been told publicly. I remember this program from having a part in the early development at the National Bureau of Standards and seeing it through the war and beyond. We did not have that development prior to the war. It was developed by forced draft. We had about 2,000 scientists working on that, and about 150,000 in the factories turning it out, and we only began to supply them in quantities around the latter part of the war.

The CHAIRMAN. When did you start, at the beginning of the war?

Dr. BRUNETTI. Let's see: I was teaching at Lehigh University at that time, so I came to Washington in 1941, in May 1941, and they had just started a few months ahead of that.

The CHAIRMAN. That was before the war?

Dr. BRUNETT. That was before we entered the war. I guess you are right. We had already started before the war, but we knew there was a situation which demanded it.

The CHAIRMAN. That is right.

Well, do you want to ask any questions, Mr. Moore?

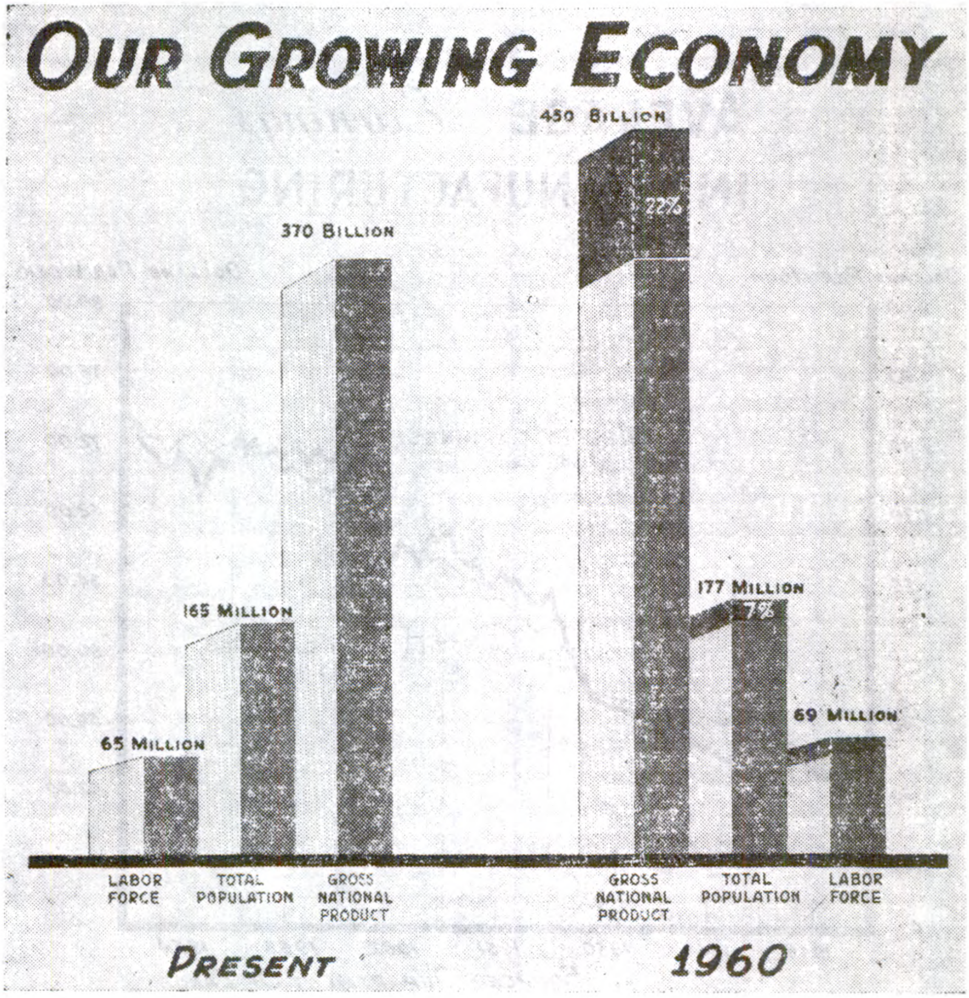
Mr. MOORE. No, sir.

The **Chairman**. Thank you again, Doctor. You have been very helpful to us. We appreciate having you.

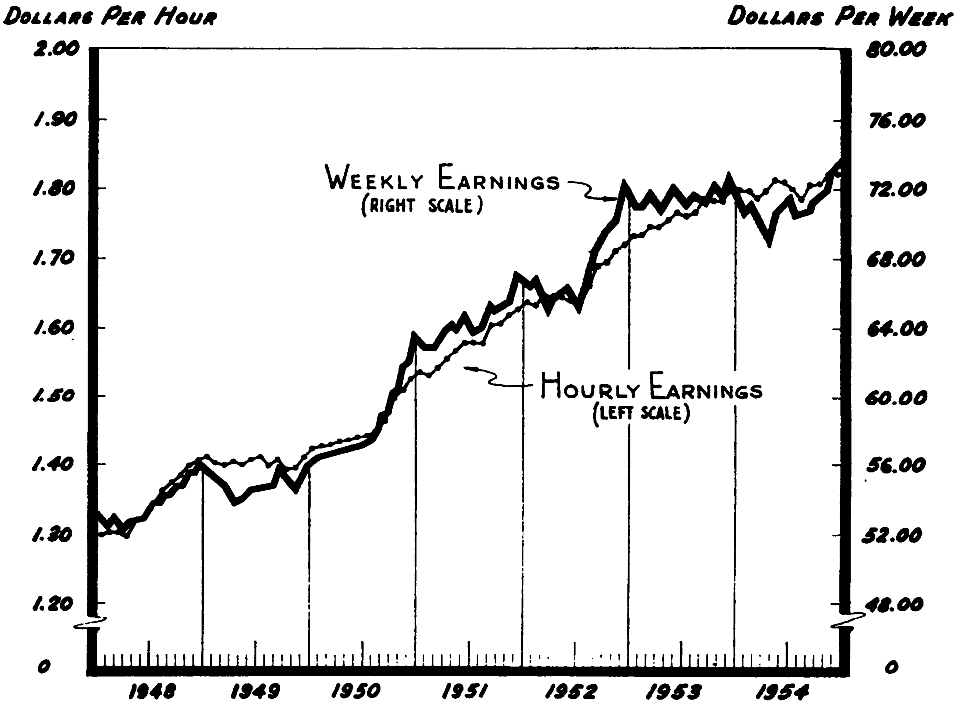
Dr. **Brunetti**. Thank you, sir.

The **Chairman**. We will recess until 2 o'clock here in this room.

(The charts accompanying Dr. Brunetti's statement follows:) .

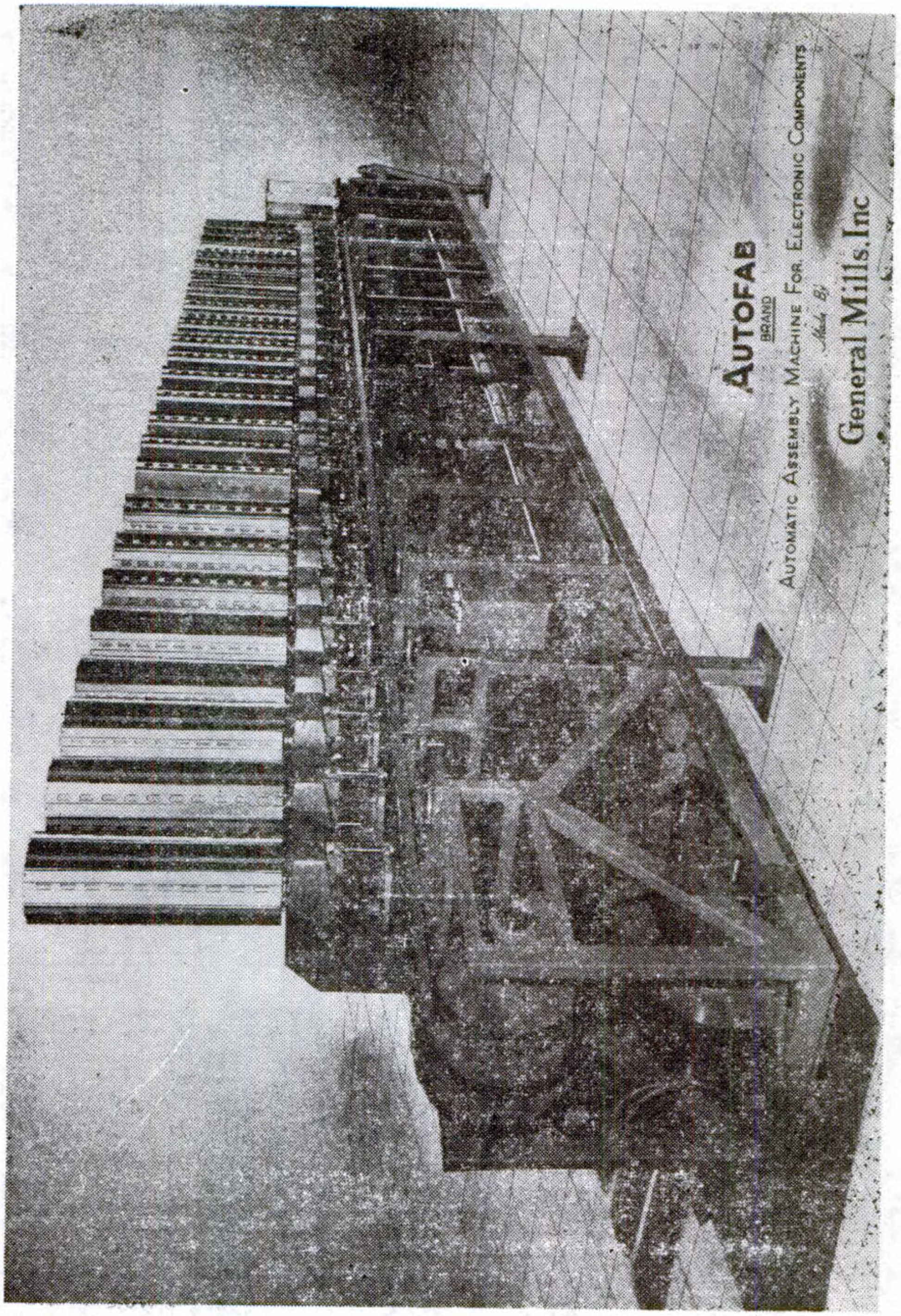


AVERAGE *Earnings* IN MANUFACTURING

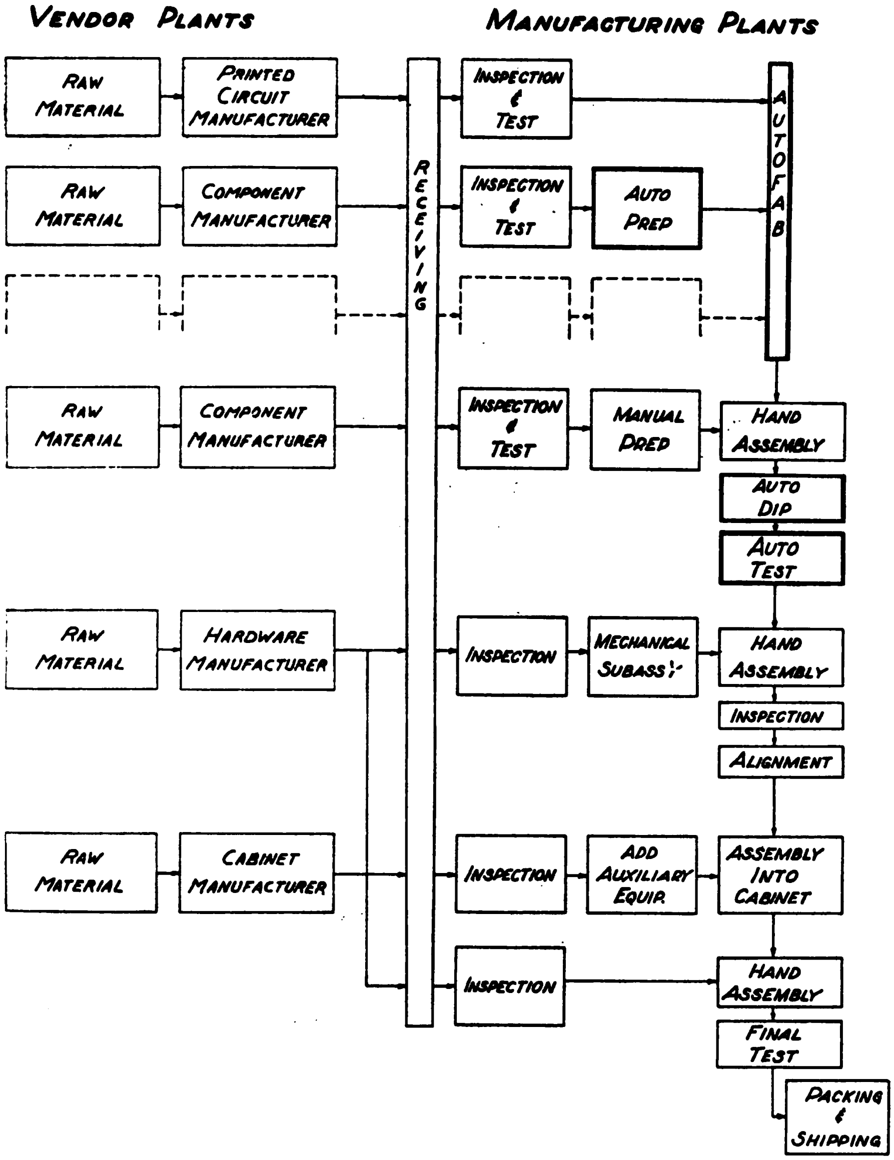


Source - Department Of Labor

Note : Data Relate Only To Production & Related Workers


AUTOFAB
BRAND
AUTOMATIC ASSEMBLY MACHINE FOR ELECTRONIC COMPONENTS
Made By
General Mills, Inc

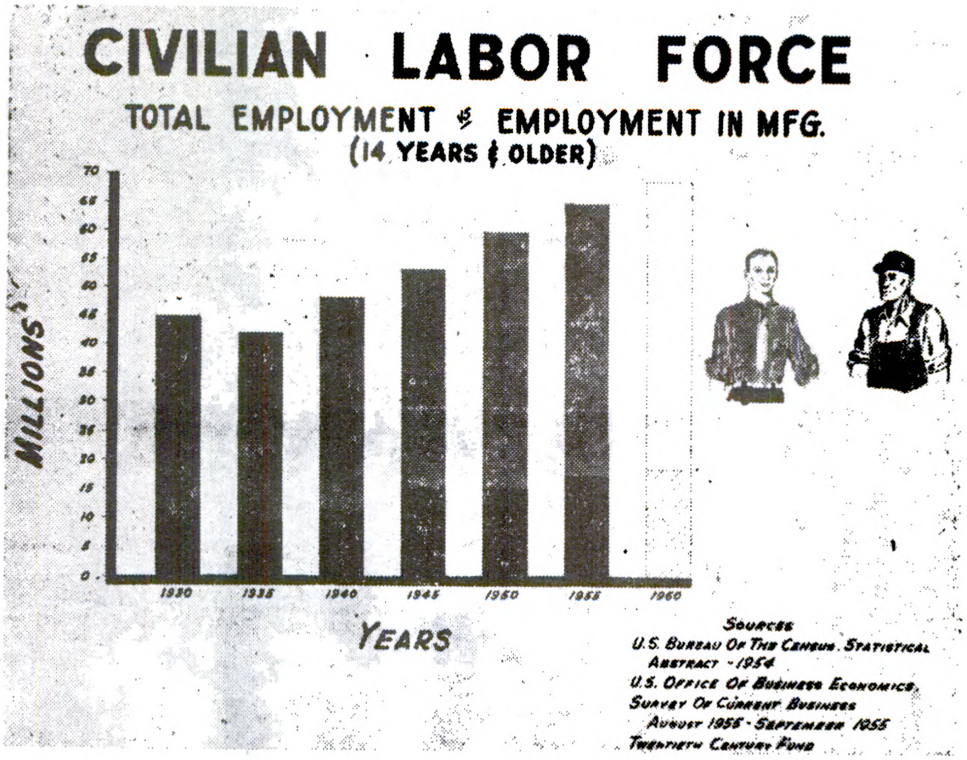
THE ELECTRONIC PRODUCTION PROCESS



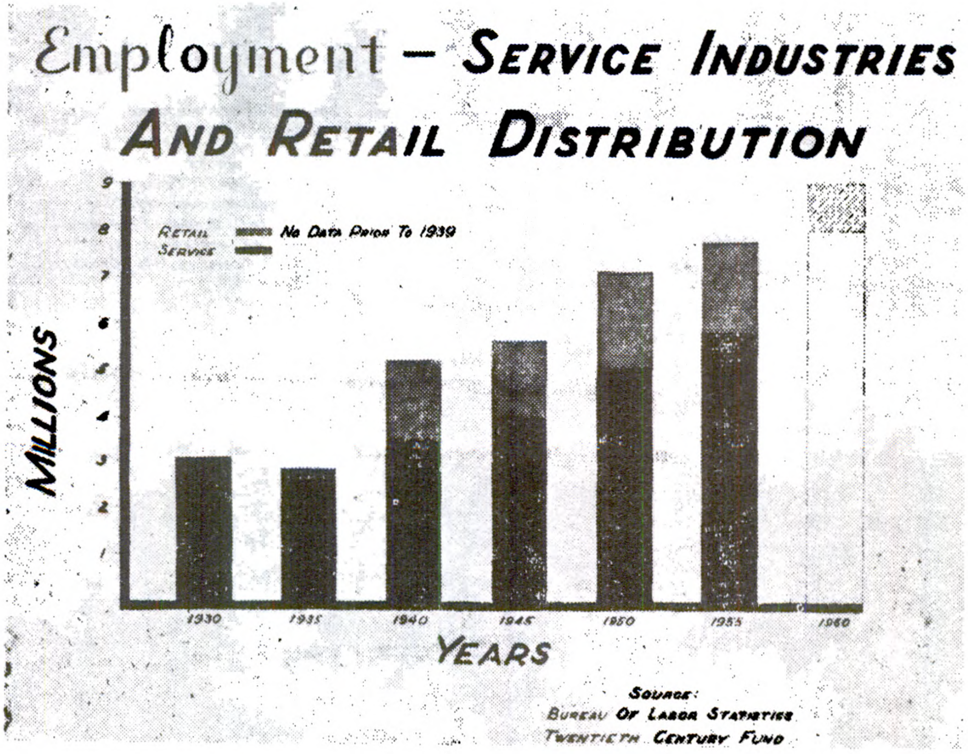
Total Employment IN SPECIFIC INDUSTRIES

(IN THOUSANDS)

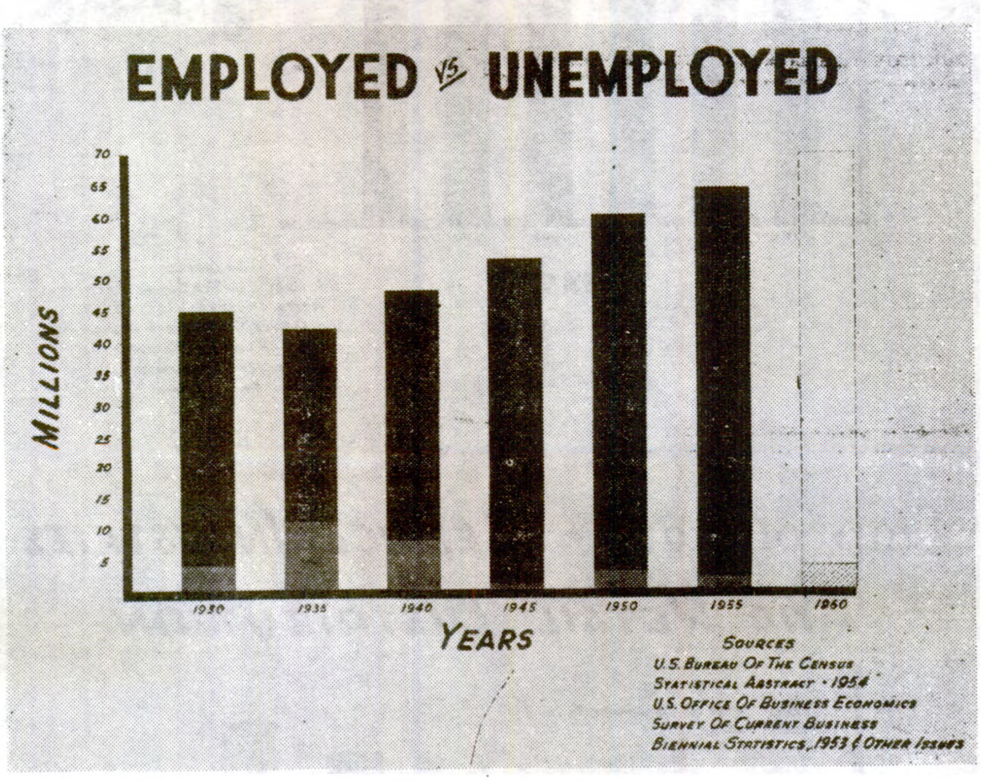
	1939	1947	1953
ELECTRICAL MACHINERY	335.2	801.3	1219.8
AUTOMOBILES	460.4	653.2	928.9
CHEMICAL & ALLIED PRODUCTS	404.2	632.3	807.0
AIRCRAFT AND PARTS	64.0	219.6	779.1
BLAST FURNACES, STEEL WORKS AND ROLLING MILLS	435.3	547.4	653.3
STONE, CLAY & GLASS PRODUCTS	337.9	462.1	543.2
AGRICULTURAL MACHINERY	74.2	171.4	167.0



SOURCES
U.S. BUREAU OF THE CENSUS. STATISTICAL ABSTRACT - 1954
U.S. OFFICE OF BUSINESS ECONOMICS, SURVEY OF CURRENT BUSINESS AUGUST 1955 - SEPTEMBER 1955
TWENTIETH CENTURY FUND



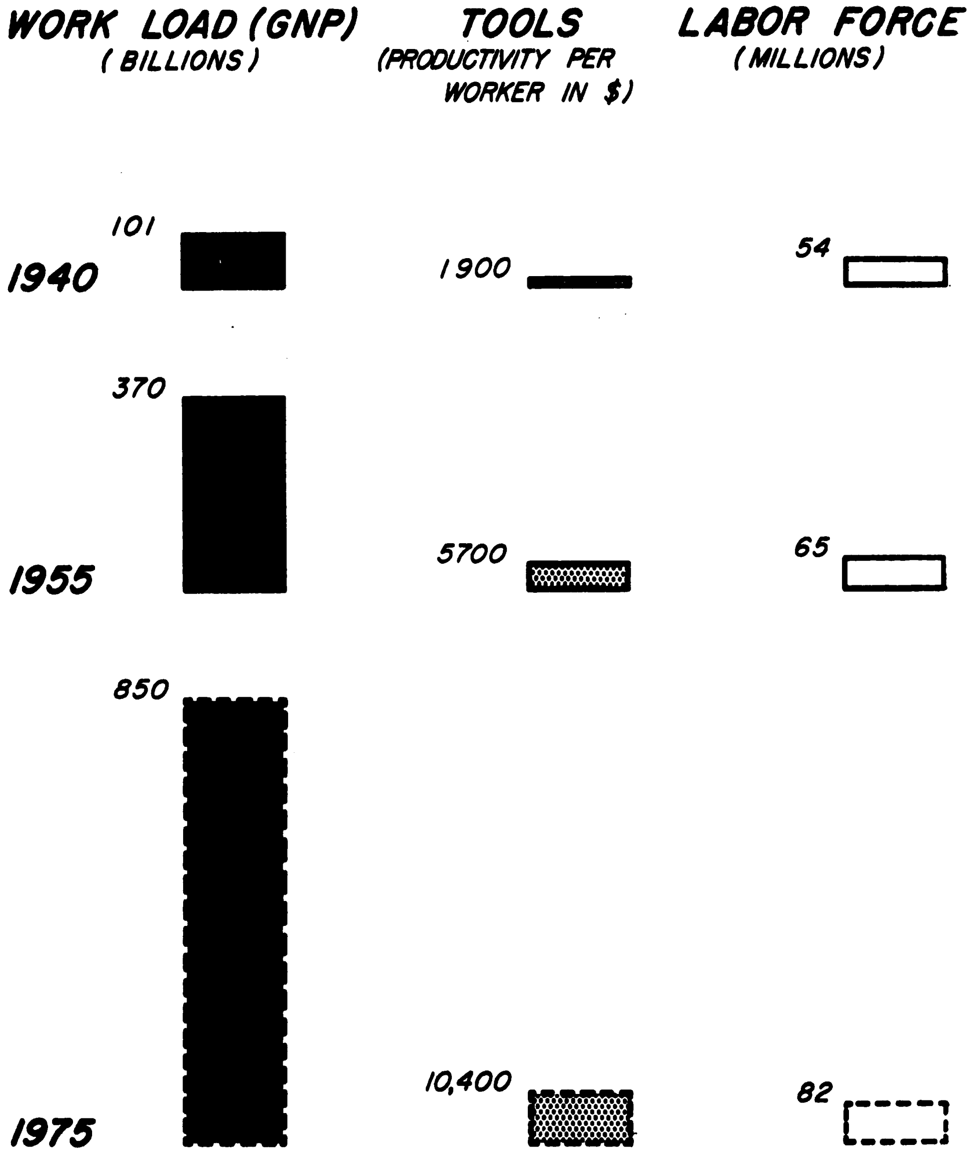
SOURCE:
BUREAU OF LABOR STATISTICS
TWENTIETH CENTURY FUND



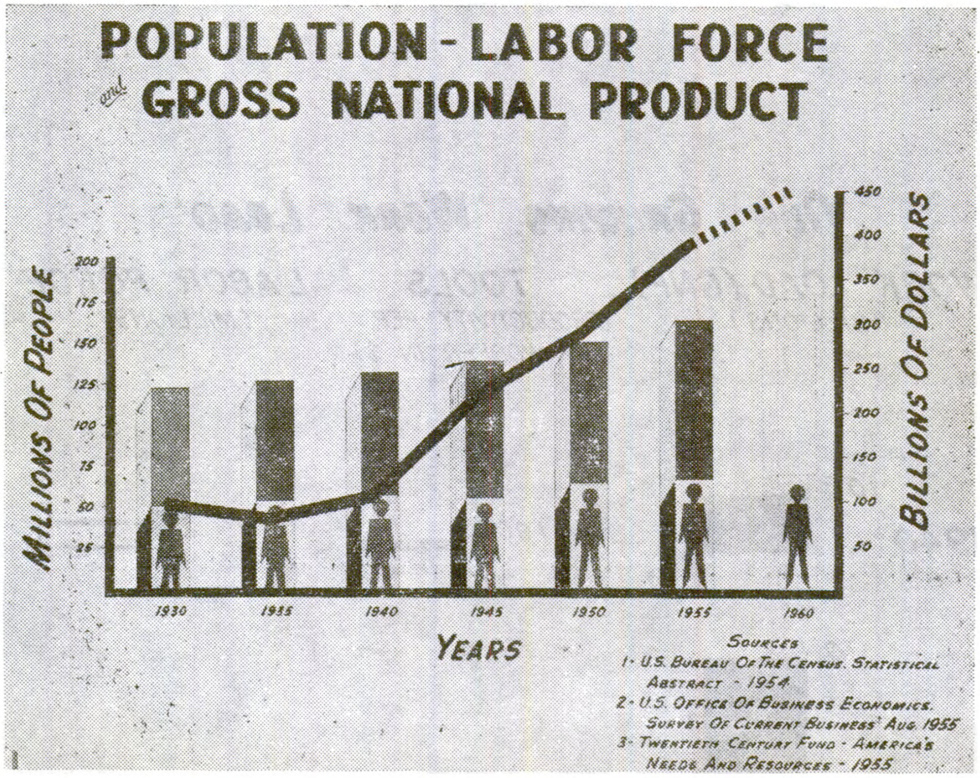
EMPLOYED vs UNEMPLOYED

SOURCES
U.S. BUREAU OF THE CENSUS
STATISTICAL ABSTRACT · 1954
U.S. OFFICE OF BUSINESS ECONOMICS
SURVEY OF CURRENT BUSINESS
BIENNIAL STATISTICS, 1953 & OTHER ISSUES

OUR GROWING WORK LOAD*

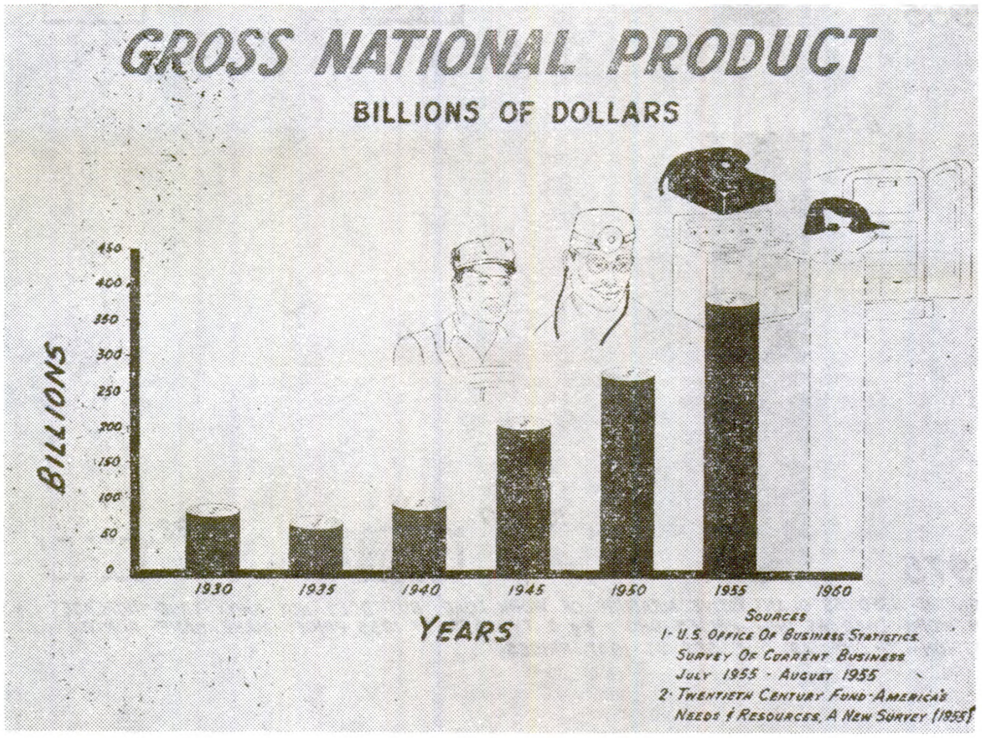


* GNP IS USED AS QUANTITATIVE MEASURE OF WORK LOAD, BUT DOES NOT SHOW TRUE INCREASE IN WORK LOAD AS UNIT PRICES DROP. e.g. 5 TV SETS AT 1955 PRICES MAKE SAME CONTRIBUTION TO GNP AS ONE SET AT 1947 PRICES



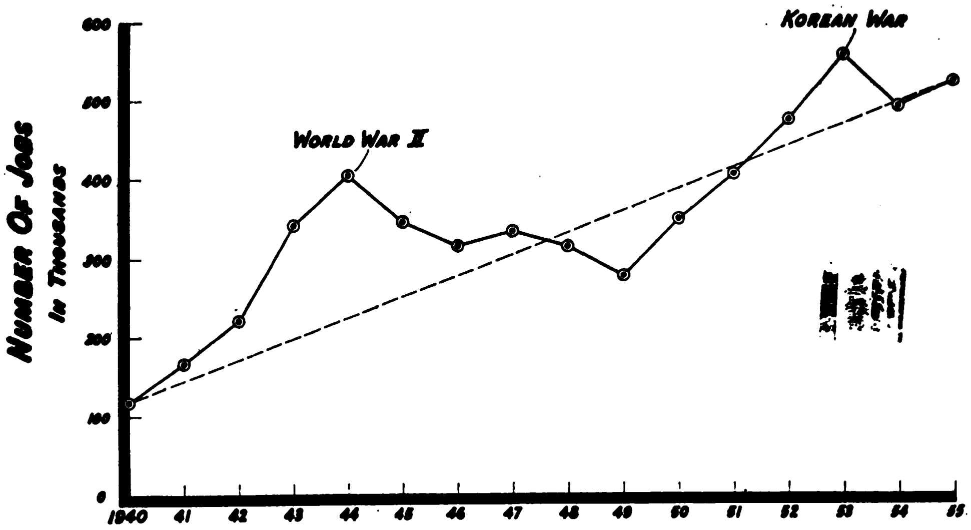
POPULATION - LABOR FORCE
and GROSS NATIONAL PRODUCT

Sources
1- U.S. Bureau Of The Census. Statistical Abstract - 1954
2- U.S. Office Of Business Economics. Survey Of Current Business' Aug. 1955
3- Twentieth Century Fund - America's Needs And Resources - 1955



GROSS NATIONAL PRODUCT
BILLIONS OF DOLLARS

Sources
1- U.S. Office Of Business Statistics. Survey Of Current Business July 1955 - August 1955
2- Twentieth Century Fund - America's Needs & Resources, A New Survey (1955)



WAGE & SALARY EMPLOYEES
IN
Telephone Equipment, Radio & TV & Electronic Tube Industries

SOURCE: DEPARTMENT OF LABOR

(Whereupon, at 12:45 p. m., a recess was taken to 2 p. m.)

AFTERNOON SESSION

The CHAIRMAN. The subcommittee will come to order.

We have with us this afternoon Mr. Marshall G. Munce.

Mr. Munce, you are vice president of the York Corp., York, Pa., a name which is known best in the refrigeration field, I believe, although you may wish to enlighten us further on that. You are also chairman of the industrial problems committee of the National Association of Manufacturers, which has made some study of automation problems and puts you in the position of having special knowledge and considered viewpoints on the subject. We are delighted to have you, Mr. Munce, and you may proceed in your own way.

You have a statement, I believe.

Mr. MUNCE. Yes; Mr. Chairman, I have a statement.

The CHAIRMAN. Yes, sir; you may proceed, sir.

STATEMENT OF MARSHALL G. MUNCE, VICE PRESIDENT, YORK CORP., YORK, PA.

Mr. MUNCE. My name is Marshall G. Munce. I am vice president of the York Corp., of York, Pa. I am also a director of the National Association of Manufacturers, and chairman of its industrial problems committee. I appear before your subcommittee as a representative of that Association.

The National Association of Manufacturers appreciates the opportunity of presenting the views of its members on this very important subject. Automation, and technological advancement in general, create new possibilities and new opportunities. All of us—Government, labor, and industrial management—share the responsibility of seeing to it that these opportunities are not wasted but are used fruitfully for the enrichment of the lives of our people.

The United States has grown to be the most productive, advanced, and highly developed of the world's industrial nations, because our inventors and scientists have worked in a climate which gives encouragement and free rein to the imagination; because our businessmen have had both the inclination and the incentive to support financially the discoveries of our scientists; and because working people in the United States, unlike in other countries, have been endowed by and large with the vision to see that technological progress always bestows its major benefits on the workingman and the Nation as a whole.

Our progress in the future, the advancement of our general living standards, and our position in the family of nations, will be in direct proportion to the extent to which we encourage, accept, and adopt scientific discovery and technological development in our economic life.

There are three points which I would like to cover in my testimony here today.

First, I would like to make clear what automation really is and remove some of the misconceptions which have come to be associated with this word in the public mind.

Second, I would like to point out what effect we believe automation will have on our economy and what it can mean to the Nation and the American people.

Third, I would like to offer for your consideration the views of industry as to what policies the Congress and the Government should follow in order to secure for the Nation and its people the maximum benefits from technological development and progress.

POINT NO. 1—THE MEANING OF AUTOMATION

Automation is a new word, and to many people it has become a scare word. Yet it is not essentially different from the process of improving methods of production which has been going on throughout human history—ever since men first took up jagged pieces of flint to perform operations better than they could be performed with bare hands. Since mankind learned to think, people have sought to amplify their efforts and produce more for their needs by using tools instead of muscles.

Modern America has led the world in the application of scientific progress to the satisfaction of human wants and has constantly opened up new frontiers for the betterment of all mankind as well as of ourselves. From our beginnings in the dawn of the steam age, we have advanced steadily into new worlds—of electricity, of the internal-combustion engine, of powered flight, of communications, of transportation, of electronics, and now, of atomic power.

At the start of our Nation, the American people committed themselves to the proposition that discovery and invention should be encouraged, and established patent laws for that purpose. American industrial management, under the spur of competition, learned long ago that it is good business to stimulate and encourage a continuous assault on new scientific frontiers, and that it is good human relations, as well as good economics, to enhance the productive power of human muscle and brains as much as possible through the use of mechanical devices.

With only an occasional skeptic here and there, the American people have welcomed and accepted this philosophy. This acceptance and welcome has been a major factor in the amazing growth and rapid development of our technology.

Had not this development come about we simply would not have been able to produce the quantities of materials and products we have today. Hand methods of producing steel never would have gotten us out of the horse-and-buggy age. In that case we would not have our acres of automobile factories, our modern oil industry, our vast number of garages and service stations, our hundreds of thousands of roadside businesses which cater to the motorist; we would have no network of modern roads, none of the great recreation centers which the automobile has made accessible.

We would still be buying our groceries from the general store and the great shopping centers to which people come from miles around would not have come into existence. We would not have far-branching capillaries of distribution which convey the mass-produced products of our factories to every town and hamlet in the land. Therefore, without mechanized methods of making steel, many of the vast industries which serve us today never could have been born. It is thus the benefits of technological progress make themselves evident in ways no man can foretell or even imagine in advance. We only know that if we need the lessons of our own history they will come.

What is considered by some to be new in mechanization today, and the reason this hearing has been called, is the development of ingenious control mechanisms, such as the electric eye, mechanical brains, and other intricate electronic and radiation devices, which can direct and control the operation of machines.

The production engineer has at his disposal a variety of machines and devices for controlling them which, when put together in proper sequence, can turn out a continuous flow of mass-produced products or materials without human hands touching them during the manufacturing process.

This is "automation," and to some people it calls up a specter of robot, workerless factories, and great numbers of people deprived of their jobs and their means of livelihood.

AUTOMATION IN THE PAST

Yet these control devices are not new. Automation is not a subject which can be discussed only in the future tense. Its essential features have been applied in a number of fields for many years. It is the word that is new, not the principles involved.

Modern petroleum refineries fit very closely the definition of the "automatic factory," which is regarded as the ultimate in automation. The substances to be treated in the refinery flow continuously through the several processes, controlled automatically by regulating devices. Human labor is used only for maintenance and for control at a few critical points. Oil refining has been on this continuous-flow basis for over 30 years.

Automatic manufacture has been highly developed for some time in a number of other processing industries. The continuous-flow technique has become the standard method of producing certain chemicals, some kinds of food, paper, and for the refining of ores. The production of cigarettes is an almost wholly automatic process.

The dial system of routing telephone calls is an example of automation which has been with us for some time. The New York Telephone Co. began installation of dial telephones in 1922.

Even in retailing, automation has a long history. Vending machines for selling various forms of merchandise date back as far as most of us can remember. So far such devices have never captured more than a small fringe of total retail trade. Whether automatic selling will become more prevalent in the future I would not venture to predict, but if it does, it will not be a brandnew development.

It is quite likely that automation will, in the future, be extended further, to new industries and new functions. The point is that automation is not something which will burst upon us suddenly at some date in the near future, bringing a whole host of new problems we have never faced before. It is a technological tendency which should be familiar to us—despite its new name.

POINT NO. 2: THE EFFECT OF AUTOMATION ON THE AMERICAN ECONOMY

It would be idle to contend that automation will not bring about major changes in the economy. If it did not, there would be no purpose in all the work of the scientists who are developing this technological concept and the production engineers who are conceiving ways to put it to work in the service of the American people.

Automation will bring about tremendous changes in our manufacturing practices, just as the development of ingenious mechanical devices to do the farmer's work brought about, and is still bringing about, enormous changes in many aspects of agriculture.

The enormous increase in the efficiency of our farmers has meant that we can get along with fewer farmers than we used to have. (See chart I.)

In the early 1800's, about 75 percent of our working population was employed on farms. The basic reason for this preponderance of agriculture was that man must be fed before he can start to satisfy other wants. With the agricultural methods which prevailed in those days, it took the joint efforts of 3 farmers to produce sufficient food above their own wants to support 1 person (and his family) engaged in a nonagricultural pursuit.

From 75 percent of our working population, the proportion in agriculture has now declined to about 10 percent. This is possible because of our improved farm productivity resulting from mechanization and other aspects of scientific agriculture. Each worker in agriculture is now able to feed his own family and the families of 9 people engaged in other occupations.

Thus, one of the most significant facts about growth in farm productivity is that it has permitted a reduction in the farm population. Perhaps you may feel that this is unfortunate—that it would be a good thing if a greater number of people were able to make their livings on farms. The fact remains that all of us—farmers included—have a much better life than we could possibly enjoy if most of our people had to be employed producing raw food and fibers. The farmer is able to enjoy more industrial products mainly because he is able to feed more industrial workers.

In many cases the improvement of production methods has increased employment in the very industries where such improvements are introduced. In these cases the product has become so much cheaper that it can be more widely used and thus more people are employed making it.

Oil refining and telephone communications have been mentioned as industries in which automation has already been applied extensively for some 30 years. In oil refining employment has increased 174 percent since 1920, and in the operating telephone companies it has increased 130 percent. In both cases the rate of increase is well in excess of the rate of increase of employment in the economy at large.

The chief reason for this situation is that the increased availability of motor fuels and of telephone service—resulting from better and cheaper ways of producing them—has led to an enormous expansion in their use. The Nation's consumption of motor fuels is now about 13 times as great as in 1920. The number of telephones in use is four times as great. These developments have more than offset the reduction in the amount of labor required per unit of product or service.

The proposition I would like to make clear to you is that technological progress must bring changes in our economy which are not only inevitable but desirable; and that arbitrary efforts to prevent change can only create problems where none otherwise would exist.

There will be manufacturing industries in which total employment will be increased through automation; there will be others in which it will be reduced; there will be still others yet unborn which will offer job opportunities of a number and nature which only the future can determine. As we become more prosperous as a result of automation, the service industries will expand—as always happens when a Nation moves up the economic scale.

Automation will and should bring about a reallocation of job opportunities. People will shift from lines of work in which their services are no longer needed to satisfy the wants of society to other and often better jobs. Surely there is nothing wrong with this. There is no virtue in keeping more people at the task of making automobiles, for example, then are necessary to satisfy public demand for the product. To do so would be to cheat society of the value of the services these people would otherwise be performing and the people themselves of the satisfactions and better opportunities which might lie in other industries.

These realinements of job opportunities should not be regarded as an undesirable accompaniment of technological progress. They are an important means by which technological advancement improves our living standards. The great increases in agricultural productivity would not have enriched our lives and the lives of our farmers if we had insisted on keeping three-quarters of our population on the farms. It is by freeing labor for other tasks that agricultural progress had made its chief contribution to the rising standard of living for all.

If I may anticipate the thoughts of the committee at this point, you may be thinking that "reallocation of job opportunities" is a glib phrase of the economic theorist which perhaps conceals a great deal of human hardship. You may be thinking that it is all very well to talk about reallocation but that the individual worker who is reallocated may undergo considerable discomfort or actual suffering in the process.

It is virtually inevitable that such cases will exist, but I can assure you with complete confidence that they will not be so numerous or widespread or so condensed in time as to constitute a social or human problem of even a minor nature, provided artificial restraints are not imposed.

Any forecast of how fast automation will proceed must be taken with a large grain of salt, but we surely are not going to wake up some morning to find that our important industries have become completely automated overnight and that half the workers are out of jobs.

One authoritative appraisal of the industries "ripe for automation" in the near future indicates that their employment accounts for only 8 percent of the total labor force. Furthermore, the same source estimates that not more than 50 percent of the persons now employed in those industries would be displaced over the next 20 years. This would suggest that the reallocation problem arising out of automation would involve about 2.5 million jobs over a 20-year period. This is hardly alarming when we recall that as great a shift was accomplished in 4 years, with very little difficulty, during the reconversion period following the World War II peak. From the peak in 1943–47, manufacturing employment declined about 2.5 million, while employment in the trade and service fields grew by about the same amount.

Furthermore, the labor force is continually reallocating itself voluntarily to an extent not generally realized. In manufacturing, in typical prosperous years, the number of persons who voluntarily quit their jobs each month runs at over 2 percent of the labor force. In other words, over an entire year the total number of quits is equal to about one-quarter of the total number of jobs. Most of these people who leave jobs voluntarily move quickly to other fields of endeavor.

Even more impressive is the extent to which our labor force, including both employed and unemployed, is in a continuous state of flux. Although there is some swing from season to season in the number of persons in the labor force, its long-term growth is a slow gradual process. Yet the comparative steadiness of the total figure, which is the figure we commonly see, is the net effect of millions of people entering the labor force each month and other millions leaving it. Census Bureau statistics indicate that on the average over 6 million people make the transition, one way or the other, into or out of the labor force, from 1 month to the next. This is in addition to millions of other persons who make some change in their status within the labor force each month. Altogether, more than 8 million changes occur each month. (See chart II.)

In this setting, even where laborsaving methods bring about a reduction of employment in an industry, very often no particular individual loses his job as a result. Each month, in the normal course of events, a considerable number of employees die, or retire, or leave voluntarily to seek greener pastures elsewhere. By not replacing these people as rapidly as they depart, reallocation occurs by attrition alone. Since the conversion of an industry to a new technology takes place gradually in most instances, this process of attrition should take care of most situations where automation dictates reallocation.

In summation of this point, it may be said that we have a highly flexible labor force due to the fact that people are free to apply their services where, when, and in what matter their individual requirements may dictate. The fewer obstacles we put in the way of individual freedom of choice, the more of this desirable flexibility we will retain.

As to the question of whether or not there will be sufficient job opportunities to which employees displaced by automation can reallocate, we can cite both logic and the industrial experience of our country.

Any assumption that automation will reduce the opportunities for employment is based on the false premise that society has only a fixed number of things to be done or a limited variety of products and services it can use and that productive power in excess of this need must inevitably be left idle.

If this premise were correct it would be easy to compute just how many people would be thrown out of work by each laborsaving change. The comprehensive statistics published by the Joint Committee's staff indicate that, on the average, we are able to produce goods and services with about two-fifths as much labor per unit as in 1910—overall productivity has almost tripled since that year. Thus, based on the technological developments which have occurred since 1910, one might conclude that three-fifths of our labor force, say 40 million people, ought to be unemployed at the present moment.

The contrast between this type of calculation and what has actually occurred, is highly significant. Despite the almost continuous decline for decades in the number of man-hours required to turn out specific products, the total number of jobs has grown enormously, along with the growth in population.

Chart III: In fact, in recent months total civilian employment has broken all previous records.

The error in some current thinking lies in the assumption that the ability of people to use goods and services is necessarily limited to some specific level or to the variety at present offered in the market. This has not been so in the past and it will never be so, unless through unwise economic policies, which destroy incentive and penalize profit seeking, we hamper invention and the development of new products and processes and stunt our future economic growth.

The historical effect of mechanization has not been to reduce employment, but to counteract, to a large degree, the effect of higher wage levels on the cost of manufactured goods. Although overall data on industrial costs are limited, it is noteworthy that over the long term, since 1913, the average hourly earnings of factory employees have increased by 746 percent. Had this wage rise not been partially offset by giving employees better tools and machinery to work with we might have expected the price of manufactured goods to increase in about the same proportion. Instead, industrial prices have increased by only 132 percent since 1913. (See chart IV.)

It is imperative, I think, for us to get away from erroneous habits of thought in connection with our economic problems and to see them clearly in the light of logic and known fact. It is essential that we understand what happens when a great new industry is born and grows to nationwide stature.

For example, it would be wrong, I think, to regard the electric light as replacing older forms of lighting, gas or kerosene lamps. What it chiefly replaced was unlighted streets and roads and going to bed at dusk. The automobile did not exactly replace the horse and buggy. What it chiefly replaced was staying at home. It gave the American people mobility, an entirely new way of living.

By the same token, we believe the development and application of automatic devices to take over the boring, stultifying jobs in our industrial plants will mean the opening up of new vistas of economic accomplishment and satisfying living which no one now can foresee.

By 1975 it is anticipated the population of America may rise to as much as 220 million people. To provide for this additional 50 million, and to continue to improve our living standards as they have improved in the past, we should aim at producing twice the volume of goods and services by that time that we enjoy today. However, our labor force will have increased only by one-third, even assuming there will be as many people wanting to work in proportion to total population as we have now. Obviously, unless we can bring about a 50-percent increase in the average output of goods or services by the individual worker, we will not reach our goal.

We are somewhere near the limit of both productivity and precision obtainable with manually operated machines. To provide the increase in output which will be necessary and the closer tolerances which many articles of the future will demand, we must make the breakthrough into automatic operation as soon as possible. The faster we can do so, despite the obstacles, the more rapidly we will reach our objective.

As automation continues we can expect to see further evidence of a process which is characteristic of all highly productive economies, a great increase in the demand for services and in the number of people engaged in the service industries. As an economy becomes more productive, there is always a movement of people from the arduous tasks of wresting the products of nature from the soil, the mines, and the forests toward the processing, distributive and service industries.

In the America of the future, we will have more people in the sciences and professions. There will be more teachers and preachers; more artists, writers, and craftsmen to hand fashion things of beauty. We will have fewer people providing for our elementary needs for food, clothing, and shelter, and more people providing for our spiritual and cultural requirements.

In industries where automation is feasible, the monotonous repetitive jobs will be done by untiring, unfeeling machines. There will be fewer people using their physical strength and many more behind the scenes keeping the production devices and their delicate control mechanisms functioning. Man will be the master of the machine rather than the servant.

Life in America will be richer, better, more rewarding, with greater opportunities for the young, increased satisfaction for adults, and more tranquillity and comfort of the aged.

In summing up our views to this point, I would like to reiterate that automation is not some sudden new concept but an extension of man's age-old quest for technological progress. Automation is essential if we are to make the next great breakthrough into higher living standards and a richer life for all.

NEED FOR NEW SKILLS

It is generally recognized that further industrial development in the direction of automation will call for a generally higher order of skill, training, and knowledge than existing industrial methods. Many of the jobs which will be eliminated are those which require only the ability to follow routine instructions. New jobs which will come into being in designing, building, programing, and maintaining the new equipment will require a broader background of understanding.

This is part of a long process in the general upgrading of human beings. We have already largely eliminated the activities which entail the expenditure of mere brute strength. We are moving in the direction of eliminating jobs which involve only repetitive drudgery.

The usual discussion of this point puts the cart before the horse. It assumes that automation may occur more quickly than people can be trained to fill the new jobs. This assumption leads to the fear that, since people will not have sufficient skill to seize the new opportunities, they will remain unemployed.

Actually the danger is of another character. The new equipment cannot be designed or built until there are sufficient trained people to design and build it. It will not be installed until there is sufficient trained manpower to operate it and service it. No business concern is going to make an expensive change in its equipment or methods without first making sure that the necessary manpower is available. Automation can occur only as rapidly as the necessary upgrading of skills occurs. Therefore, the real danger in failing to have enough trained manpower is not unemployment, but a slowing down of technological progress. The availability of scientific and technical personnel is a matter of grave concern to all of us.

NEED FOR CAPITAL

The essence of automation, and of laborsaving in general, is that it substitutes inanimate machinery for human labor in the performance of particular operations.

We have devoted some time to answering the question: "Where does the labor go?" We should also give some thought to the other side of the coin: "Where does the new equipment come from?" New equipment costs money It can be installed only if someone invests the funds necessary to buy it.

Automation's new potentialities for human betterment may be forfeited if industry cannot obtain the capital needed to put them into effect. Saving and investment always play key roles in promoting human progress.

POINT NO 3. POLICIES FOR AUTOMATION

Automation clearly will be a blessing to the Nation if it is allowed to grow by natural economic selection and if it is not distorted by unwise and unnecessary efforts to thwart its effects. Our first resolve must be to understand automation and to forego the present persistent effort to scare the public into fearing this great new step forward.

Labor, industry, and the Government all should shape their policies and their public pronouncements toward welcoming automation and fostering its growth. Factors which hinder its widespread introduction should be examined carefully. Concern for the long-range overall good of the Nation and its people should take precedence over selfish jockeying for special advantage or throwing roadblocks in the path of automation by demanding advance commitments to labor.

The objective of automation is to create a vast abundance of products and services. There will be no point, however, in creating this abundance unless it is used by consumers. Therefore, markets must be widened to the greatest possible extent; the buying power of all consumers must increase. This is but another way to describe the steadily advancing standard of living which is our national objective.

The most effective way to increase the buying power of all consumers is through reduction of the cost of the goods and services they buy. In this way those on fixed incomes and those whose incomes are slow to rise can benefit as well as those who are on salary or wages.

Allowing costs to fall as automation proceeds serves to minimize the ensuing redistribution of employment opportunities. The industries in which the greatest productivity gain is achieved through automation would be under these circumstances, the industries in which costs would drop the fastest. As a result, markets for the products of these industries would be broadened, and this would go far to offset, or perhaps more than offset, the reduction in the amount of labor needed per unit of product and maintain, or possibly increase, employment in those industries.

With the power presently in the possession of union leadership, the Joint Committee on the Economic Report might well be concerned that such power is not used to harm the interests of the Nation and the people as a whole by demanding for wage earners, to the exclusion of the rest of the populace, the full benefits of the productive efficiency which automation makes possible.

These benefits must be shared by all consumers as well as by wage earners if they are to be realized at all. If union leadership continues to demand wage increases, which discount in advance the savings to be made by automation, reductions in price will be impossible. Hence, the wider markets which are the reason and the justification for automation will have no opportunity to germinate. They will be erased before they get a chance to exist.

TAX POLICY

Automation will require large amounts of capital and the present discriminatory structure of Federal tax rates confiscates potential savings and acts as a deterrent to investment. It is small service to the so-called little fellow to relieve him of a few dollars in income taxes each year if thereby he is cheated of the much greater monetary, physical, and spiritual rewards, and of the wider opportunities which are sure to come his way as the efficiency of our industrial machines can be increased.

NAM has proposed an orderly, coordinated plan for a gradual reduction in corporate and individual progressive tax rates for effectuation over the next 5 years, to be financed out of the growing productivity of the Nation. The details of our tax program have already been presented to Congress in the testimony of Wm. J. Grede, chairman of our Taxation Committee, before the House Ways and Means Committee on June 28, 1955. The goal we propose is a top rate for both taxes of 35 percent by the end of that period. We ask that the joint committee study carefully the reasoning and mechanics of this proposal. In our opinion, it would be a major factor in bolstering the economy and increasing our productive output and standard of living.

PATENT POLICY

Our historical patent system must be preserved. It has contributed greatly to the high standard of living of the American public and to our world leadership in modern technology. Ill-advised attempts to alter or weaken that system would inevitably impede our future progress.

For example, proposals for the compulsory licensing of patents would destroy the exclusive property right provided for in the Constitution and should be opposed. The incentive which the patent system now affords, particularly to small business, would be largely removed, and the investment of risk capital in new industries discouraged.

INDUSTRY'S POLICIES WITH RESPECT TO AUTOMATION

Industry must proceed boldly and with confidence to do always the best job it knows how in improving productive efficiency. It must be dynamic, forward looking, ready to accept and adopt new ideas. Its objective should be to share fairly the fruits of technological progress with all elements of the economy, with labor, with consumers, and with investors.

We are confident that virtually nothing is impossible to a free people if we cling to the principles of freedom, individualism, and competitive enterprise which have been our traditional guides. We see no problems in the offing in connection with automation except those which we may create ourselves through unwise action or foredoomed efforts to alter or distort the smooth working out of our economic destiny.

If we continue to have faith in economic freedom, and affirm that faith in word and deed and national policy, we can proceed into the glorious future at the threshold of which we now stand.

(The charts referred to by Mr. Munce are as follows:)

CHART I

AS ONE FIELD OF EMPLOYMENT DECLINES OTHER EMPLOYMENT OPPORTUNITIES INCREASE

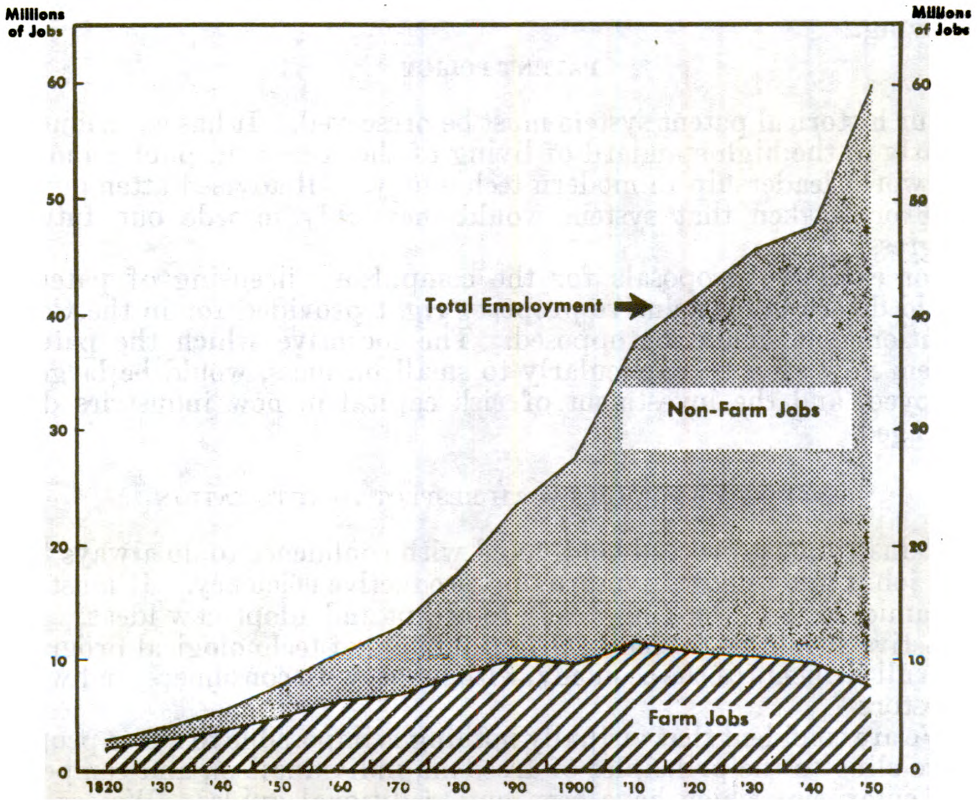


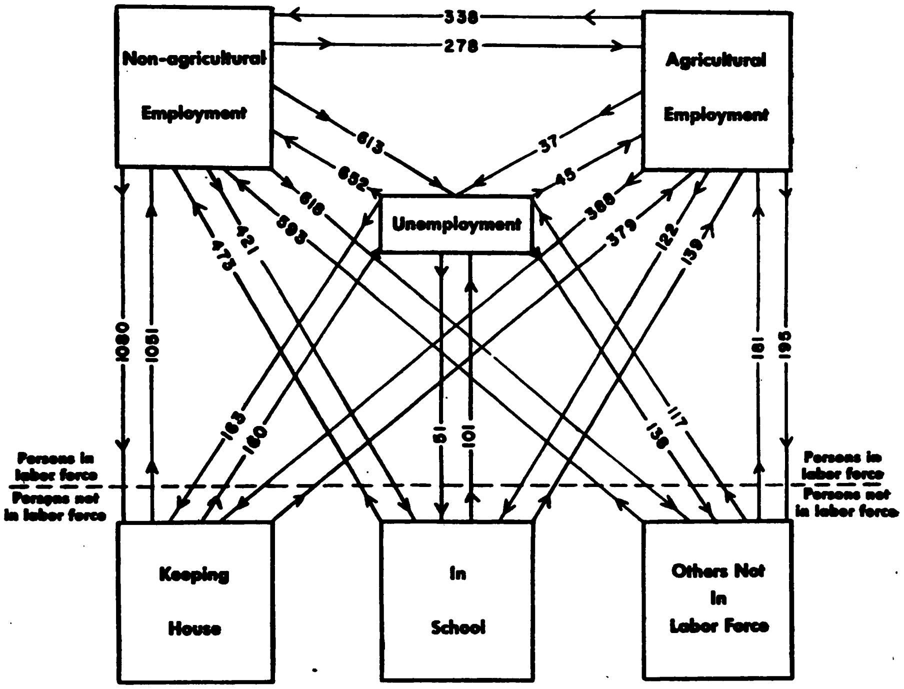
CHART II

MILLIONS OF JOB CHANGES EVERY MONTH

TYPICAL MONTHLY CHANGES IN LABOR FORCE STATUS

AVERAGE CHANGE, FROM ONE MONTH TO THE NEXT, DURING THE YEAR, 1952

(Thousands of persons)



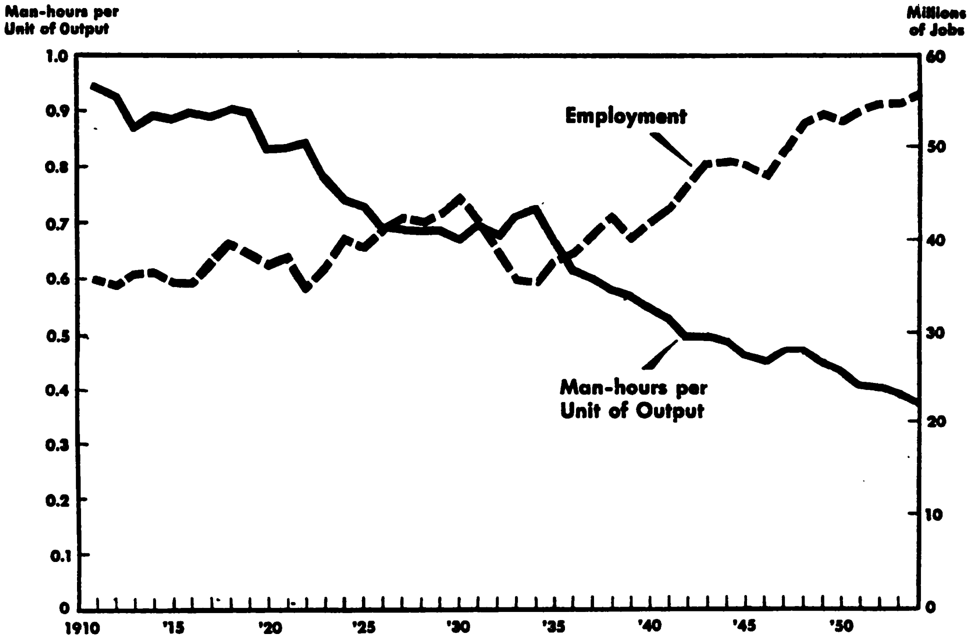
SUMMARY OF MONTHLY CHANGES

Total number of shifts in status, as indicated above	8,333,000
Number of persons entering labor force	3,193,000
Number of persons leaving labor force	3,174,000

Sources: U. S. Census Bureau

CHART III

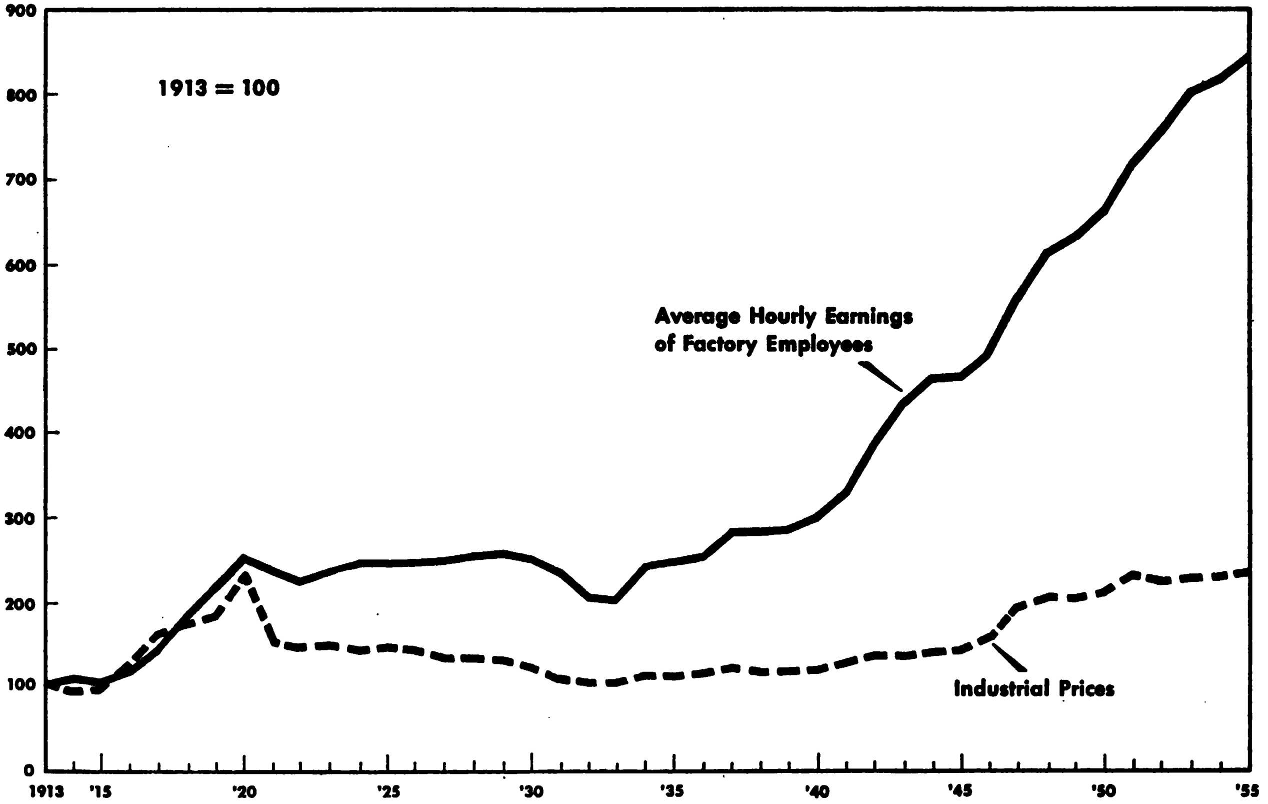
JOBS INCREASE WITH LABOR-SAVING IMPROVEMENTS



Source: Man-hours per unit is the inverse of data published by staff of the Joint Committee on the Economic Report. Employment (excluding government) is a linked series from data published by government, National Industrial Conference Board, and National Bureau of Economic Research.

CHART IV

MECHANIZATION PARTIALLY OFFSETS THE EFFECT OF HIGHER WAGE COSTS ON PRICE



Source: U. S. Bureau of Labor Statistics

Mr. MUNCE. Now, Mr. Chairman, following the written testimony which you have before you, and which I have just read, there are four charts which are parenthetically referred to in the testimony, and which I will not discuss in detail, which I think are self-explanatory, and which bear out the statements made in the testimony I have read.

Thank you very much, Mr. Chairman.

The CHAIRMAN. Thank you very much. Your testimony and charts are very interesting.

I want to ask you some questions about how you arrive at the price of a product, and that is in connection with taxes and other questions that you have raised here in your testimony which are very thought provoking.

You referred to raising of capital. What are the general rules about how much a company should earn? I have always understood that where an industry had the right to fix the prices, itself, or to obtain the prices it seeks, that it should keep in mind that it should only have a price that would be sufficient to pay all operating expenses, of course, including everything that goes with it—salaries, wages, taxes, depreciation, and obsolescence—and then a fair return to the people who have invested their capital in the business.

I assume that you will agree that at least the prices should be high enough to include those items and should the prices be high enough to include other items, if so, what are those items?

Mr. MUNCE. Mr. Chairman, I am afraid that I don't follow you. I cannot quite conceive of the other items that you have in mind.

The CHAIRMAN. Maybe I can clarify it even more.

I have looked upon, unfavorably, the past few years, so many concerns getting their capital for expansion and investment, not in the market place where they go and borrow the funds, by selling bonds that bear a certain percent interest, or by selling stocks upon which they would pay a dividend, but they get the money by charging the customers, the consumers, more for their product, and at the end of the year, after they have paid all their taxes, and operating expenses, set aside sufficient amounts for obsolescence and depreciation, and paid their stockholders a fair dividend, they set aside for investing in the business huge amounts which represent "costless" capital to them, the way I view it. They then use that "costless" capital in competition with other businesses that are forced to borrow their money. I am apprehensive that we are permitting, by tolerance, the building up of a system in this country that is crushing to the little man, and to competitors, that don't have that advantage. What would be your comments on that?

Mr. MUNCE. Mr. Chairman, I will try to comment, in answer to your questions, directly, although I am not sure I am fully capable of expounding a direct answer to all of the inferences that you have made.

First of all, I think that you will agree that management of industry should adhere to the same principle that the individual should adhere to, if he is a wise individual, and that is put some aside for the rainy day. Therefore, he should not pay all out in dividends that he may make in a single year.

Secondly, the amount that he is entitled to set aside—let me change that: The amount that he is entitled as management, setting up this structure that you referred to, is somewhat dependent upon the risk or hazard of the business, or the interprise that he is in. I think that is a commonly accepted concept.

Now, I think the answer to your question perhaps lies in the fact that no business can stand still, and if you pay out all in dividends, and if you do not put some aside for a rainy day, and eventually use some of that for improving the business—and expanding is one way of improving business—expanding may be internal improvement, or it may be volumetric expansion, but it is improving the business. If you do not improve the business you are stagnant. You are static. You become stagnant and eventually you slip so you must set aside some, and you must use some of that to keep up with your competitors, and I strongly believe in the free enterprise competitive system that exists in this country.

I think it is the greatest inducement to progress that we have anywhere in the world.

The CHAIRMAN. You don't think that in all industry we have much genuine competition, do you?

Mr. MUNCE. Yes.

The CHAIRMAN. In all industries?

Mr. MUNCE. There may be exceptions, and there are undoubtedly exceptions.

The CHAIRMAN. The automobile, for instance. Do you believe there is any real competition in it?

Mr. MUNCE. I do not know enough about the automobile industry to answer your question directly, Mr. Chairman.

The CHAIRMAN. I will not press you on that.

By the way, this is off the record.

(Discussion off the record.)

The CHAIRMAN. Back on the record, please.

What concerns me so much is this: concerns in the retail business, for instance, have thousands of outlets, and not only make the money that I was speaking about a while ago—enough to pay all expenses and dividends—but they set aside enough to open up new businesses. And, the new businesses they open up in competition with existing businesses is really with costless capital on them.

In this great free-enterprise system of ours, which I believe in, and this fine competitive system that we have, it doesn't seem fair to the young people or others who have got to go into the market place and borrow their money and pay interest on it, and in that handicapped position, so to speak, compete with the big concern across the street, which has built itself into a fine unit, with costless capital. Don't you think that that could mean a real problem?

Mr. MUNCE. Mr. Chairman, I am a manufacturer, and I therefore hesitate to risk an opinion on retailing, but treating with the subject in general, and not with the retailing that you have referred to, I do not look at it the same way you do. I look at it, that the money that is reinvested, that you have termed "costless capital," is in no ways different from the money that might be paid out to stockholders and then put up by stockholders, back into the company, for the additional expansion. That is the way I look at it.

It is stockholders' money, stockholders' interest that you are spending, and management is always conscious of the fact that the company,

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assuming, of course, a publicly held company, the company belongs to the stockholders.

The CHAIRMAN. Of course, that expression "costless" capital was not coined by me. The first person I ever heard use it, I believe, in a congressional hearing, was the president of General Foods, Mr. Clarence Francis. It is not one of these socialistic, communistic phrases. It was used by Mr. Francis the first time I ever heard it, but it is such an apt phrase, I think, for the reason that consumers should not be required to pay for the expansion of any industry. I don't think that the consumers should be required to pay a price more than enough to properly compensate a company for all operating expenses, and taxes, and set aside so much for obsolescence, depreciation, and then a fair share for the stockholders. I think anything above that should be reflected in lower prices. If the company wants to expand, it will be in this competitive system you are talking about. They will be in real competition with everybody else. If they want to expand they will get their money the same way the other people get their money. That is just my thinking about it. If I am wrong about it, I would like to be set straight.

Mr. MUNCE. Mr. Chairman, I will interject this: I think the company that does insist upon the price, or tries to collect a price more than a proper, reasonable return, more than consistent with a proper, reasonable return, immediately makes himself peculiarly vulnerable to competition, and I think the competitive enterprise is a leveling influence on that situation.

The CHAIRMAN. Of course, you could almost get facetious about this competition, because we know in some industries they don't actually have it; in theory, of course, that is right.

You mentioned about an 8 million turnover, Mr. Munce; that I didn't understand. I just wanted you to explain that a little bit more to me, if you will.

Mr. MUNCE. Mr. Chairman, if you will refer to chart II.

The CHAIRMAN. You state here that the Census Bureau statistics indicate that on the average over 6 million people make a transition in one way or the other into or out of the labor force from one month to the next. This is in addition to millions of other persns wh make sme changes in their status within the labor force each month. Altogether, more than 8 million changes occur each month.

I just wondered how that could be. That means about an 8-month turnover for the entire industry.

Mr. MUNCE. If you will turn to chart II, sir, appended to the testimony, you will find, I think, a very interesting chart, which has been prepared by the NAM staff, from the United States Bureau of Census statistics, and I think that chart is very revealing, as it indicates a tremendous in and out of jobs every month. Therefore, the figure we are quoting of 8 million, which is further stated at the bottom of the chart, is taken from the Bureau of Census figures.

The CHAIRMAN. That is inconceivable to me. I am not disputing your figures because you have looked into it, and I haven't.

Mr. MUNCE. I think the figures shown on this chart are surprising.

The CHAIRMAN. We have 65 million people working, and if 8 million change every month, that is a complete turnover in 8⅓ months. Of course, I know it is not the same people turning over, but that makes the others have rather rapid velocity.

Mr. MUNCE. I think it is surprising, sir, but it is a fact.

The CHAIRMAN. I am not questioning your figures. You know, and I don't, but it just doesn't sound right to me.

Mr. MUNCE. If the committee staff wishes further reference to that——

The CHAIRMAN. We are going to look into it.

Mr. MUNCE. I can refer you, sir, to the Bureau of Census publication Current Population Reports, Labor Force, dated July, 1953.

The CHAIRMAN. Well, we appreciate the information you gave us, and those of us who are not convinced will look into it and try to convince ourselves.

Anyway, we are not questioning your statement or material. Thank you very much.

Mr. Moore, do you have a question?

Mr. MOORE. As one who is familiar with the air-conditioning field, it has been suggested to me that many of these automated factories, because of the expensive equipment that they use, and because of the electronic controls, must of necessity be air-conditioned as compared to the older factory. Is there any element of truth in that? To what extent is air conditiong of factories, a corollary to automation?

Mr. MUNCE. I think I will answer you this way: It is an established fact that the preservation of close tolerances is a function of temperature, and to obtain constant temperature, and thereby obtain very close tolerances, you require temperature control, which is one phase of air conditioning.

The second phase of air conditioning, which enters into industrial manufacturing, is the effect of moisture, either on the hands of the worker or on the product itself, and that is a second phase.

Therefore, I think the answer, to summarize, to your question, is that air-conditioning makes possible greater precision than would otherwise be without air conditioning.

Mr. MOORE. As sort of a corollary to that, that would be an increase in the maintenance function, I suppose, in keeping a plant ventilated and cleaned?

Mr. MUNCE. That is correct.

The CHAIRMAN. Mr. Ensley, do you have something?

Mr. ENSLEY. No, sir.

The CHAIRMAN. Thank you very kindly.

We had hoped at this time to hear from Mr. James J. Nance, president of the Studebaker-Packard Corp., or one of his representatives. We were particularly interested in learning firsthand how the trend toward automatic machinery in the automobile industry is expected to affect the degree of concentration of production. The question in everyone's mind is whether the drift toward more and more automatic equipment is going to make the life of the so-called independents better or worse, relatively.

Unfortunately, one of the problems of being a relatively small business is that you have to fight hard to stay in the running. We have been advised that the Studebaker-Packard Corp., while anxious and willing to appear, simply does not have the manpower to manage all of the problems which are presented by their competitive position and to be here this afternoon to testify as well.

They have, however, agreed to submit a statement which will be incorporated into the record which we shall certainly read with interest. While I, of course, have not seen this statement, I gather that those in the company have great faith that they can somehow adjust to the impact of increasingly expensive production equipment.

(The following was later received for the record:)

STUDEBAKER-PACKARD CORP.,
Detroit, Mich., November 7, 1955.

Hon. WRIGHT PATMAN,
Chairman, Subcommittee on Economic Stabilization, Congress of the United States, House Office Building, Washington, D. C.

DEAR CONGRESSMAN PATMAN: We submit herewith a statement on behalf of Studebaker-Packard Corp. in connection with your subcommittee's study of the problems arising out of the trend toward automation.

I regret very much that at the time of the hearings I found it impossible to attend or send a representative of the corporation to testify. We had at that time (and still have) a serious labor union negotiation in progress, and our corporate officer best qualified to deal with the subject was, and still is, devoting 100 percent of his time to the labor problem. We appreciate your courtesy in permitting us to submit a written statement in lieu of appearance, and appreciate also the courtesy and understanding of our problem evidenced by the subcommittee's staff economist, Mr. William H. Moore.

The enclosed statement is for the record of the subcommittee if you wish to include it, and we hope that in some small way it may contribute to your study.

Again, with sincere thanks for your considerate dealing with the corporation, I am,

Sincerely,

J. J. NANCE.

STATEMENT OF STUDEBAKER-PACKARD CORP.

This statement is submitted by Studebaker-Packard Corp. at the invitation of the Economic Stabilization Subcommittee of the Joint Congressional Committee on the Economic Report, for incorporation into the subcommittee's study of the implications of industrial automation.

It is our understanding that the committee wishes to have an expression from the management of the corporation of its views on the industrial and social effects of the trend to automatic processes, with particular interest attached to the position of the corporation as a smaller producer in the automobile industry.

We have examined the published statements of others who have given testimony to this committee, and note that the general subject of automation already has been covered in some detail. This statement, therefore, will avoid repetition of such matters as defining automation and summarizing its general history to date.

Inasmuch as the committee has made particular inquiries concerning the effects of automation in the automotive industry, we believe that the specific and most useful service we can render is to state our experiences and our viewpoint as a smaller manufacturer in the automotive field.

We should first preface these statements by pointing out that our position as a smaller company in the automotive industry is not necessarily illustrative of what is generally meant by the term "small business."

Because the American automobile industry is tremendous in size, a company relatively small in the industry can be large by the standards of business in general. It is possible, in other words, to be a large manufacturing company and still not realize a great percentage of the auto industry's production. Studebaker-Packard's present production capacity, for example, is some 470,000 units. On the basis of an 8-million-car year, such as 1955, this would represent less than 6 percent of the industry's total output. However, in terms of sales dollars it would represent a billion-dollar year. The company has not produced to capacity, but nevertheless its current sales volume, its assets, and total worth place Studebaker-Packard Corp. among the 150 largest industrial concerns in the United States.

The management of Studebaker-Packard Corp. believe that automation is an inevitable part of evolution of the technology which has been a major factor in creating a continuously rising standard of living for the citizens of the Nation. The program of the corporation contemplates growth, and we recognize that this cannot be achieved without the employment of automatic manufacturing processes whenever this will result in the production of quality products at more favorable costs.

The corporation has a substantial background of experience in this field. It has today some of the most modern automatic manufacturing facilities in the automobile industry. For example, its 1-million-square-foot Packard engine plant at Utica, Mich., is among the newest of its kind, and is regarded as a model of modern mechanization and automated production. In the manufacture of V-8 engines in this plant rough cylinder blocks start through a 131-station operation by being placed on conveyors that feed them to fixtures which precheck the castings. The blocks progress 1,100 feet through a series of transfer machines where multiple machining takes place. Tool control boards provide continual inspection and visually alert the operators when tools at each station require changing or adjustment.

The entire process, with its continuous, almost infallible inspection, has made possible a product highly competitive in cost and quality. At the same time, it provides safer working conditions an upgrading of jobs for many workers, and an increase in skill levels and in the number of maintenance employees.

Engines built in the Utica plant are the biggest and most powerful to be offered in American passenger cars in 1956. The new plant has an annual capacity of 160,000 engines, and is currently providing engines for two other makes as well as for Packard and Clipper cars.

Obviously, a facility of this kind requires substantial capital investment, and it seems probable that the progress of automated processes will require such expenditures on a basis accelerated over what has heretofore been regarded as normal. In order to gain the benefit of the capital investment in an automated facility, the maximum use of the machines must be obtained. The plant, therefore, must run at or near its capacity, and the necessary volume of production and sales need to be accomplished in order to achieve this. Once the needed volume is reached, however, the relatively smaller manufacturer enjoys production costs as favorable as those enjoyed by a larger manufacturer. If, for example, a line of machines for automatic production of engines has a capacity of 60 engines per hour, a manufacturer with need for a greater number of engines must duplicate the line, and does not, therefore, enjoy any substantial production cost advantage. If, on the other hand, engines are produced in nonautomated plants employing many hand operations, the larger manufacturer is able to spread supervision and plant overhead costs over a greater production and thereby is able to enjoy lower costs per engine produced. Automation, therefore, can result in the benefit of a tendency to equalize manufacturing costs as between larger and smaller producers, provided, always, that the smaller producer attains and maintains the necessary sales volume to justify the operation of an automatic line at or near its capacity.

Automation, in our view, does not in itself present a major problem for the relatively smaller producer in the automobile industry. Automatic processes do not, per se, require extreme size—a relatively small volume producer in an industry as large as the automobile industry can use automation effectively. The problem of such a manufacturer is to secure and maintain, in the face of the marketing strength and advertising expenditures of its larger competitors, the sales volume needed to permit it to enjoy the advantages of automation, and to create the earnings necessary to make the captital investments required for the purchase of automatic facilities.

It should be noted also that there seems to be a widespread misconception that the automobile industry is highly automated, and that almost every operation in the plants of the large auto makers, from the entrance of raw materials to the completion of finished cars, is automatic. This is not true; no more than a relatively small percentage—certainly not more than 6 percent—of the operations of any auto maker fall into the automated class. There are many industries more highly automated than the auto industry for the simple reason that the manufacture of their products is more readily automated than is the manufacture of automobiles.

As a smaller motor car manufacturer, Studebaker-Packard Corp. has not suffered any competitive or other disadvantage due to introduction into the industry of automatic processes. On the contrary, we believe that automation as it is known today can and will be a major factor in offsetting advantages which might otherwise inhere in sheer size of manufacturing facilities.

A good deal of testimony has been furnished the subcommittee concerning the effects of automation on possible displacement of workers. It would burden the record unnecessarily for us to do more than touch briefly on the subject.

The introduction of new technology can always result, at least in local and temporary displacements. So long as we have an expanding and growing economy, the effects of this will be minimized. In our own experience, the introduction of automatic processes did not result in any problem of this nature. The substitution of machines for human labor has, in the final analysis, reduced toil, created needs for greater numbers of more highly skilled, higher paid workers and technicians, improved working conditions, permitting manufactured goods to be placed in the hands of more and more people, and produced an ever increasing standard of living.

We believe that your subcommittee performs a valuable public service in its careful examination of the social and economic considerations involved in the progress of automation. If those most directly concerned with the introduction and expansion of automatic processes profit by your example, we are confident that problems created by automation will be dealt with in such a way as to preserve human values and the benefits of our economy.

The CHAIRMAN. I have some more statements here, one from Mr. Frank B. Powers, on automation in the telegraphs. He is a public relations consultant. That will be inserted in the record at this point.

(The information is as follows:)

AUTOMATION IN THE TELEGRAPHS

(By Frank B. Powers, public relations consultant)

Automation has meant the loss of some 57,000 jobs in the telegraphs. Prior to merger of Postal Telegraphs with Western Union, about 25 years ago, the combined personnel of the telegraphs was 92,000. A few months ago, approximately 35,000 were reported as employed by the monopoly company, Western Union. The figure is accepted by the company and the Commercial Telegraphers' Union as approximately correct.

It is not believed the volume of business or messages handled by Western Union has changed materially. It is difficult to make comparisons, for much of the WU wire space is leased out, so that lessees may handle an unknown number of telegrams and wordage by using its own operators, and not recorded.

In Western Union, automation has come close to the push-button stage. One operator can now punch tape, on teletype or transmitter, the tape being automatically relayed from one city to another without further manual attention until it is finally delivered to the consignee.

Western Union has 16 switching centers throughout the Nation. Messages once punched can automatically be relayed without further handling, sometimes with no more than the pushing of a button.

A facsimile or Deskfax machine is now delivering the message from the receiving point to the customer, eliminating the familiar messenger. The customer or his employee may originate the telegram from his desk, eliminating any further handling by a WU employee if the consignee has a similar Deskfax.

Formerly a transmitting and receiving operator were necessary at from 1 to 3 or more relay points. Additional employees at the receiving point were needed to prepare the message for delivery.

In the Associated Press, United Press, and International News Service, telegraphers are now setting type by wire. The transmitter is known as the teletypesetter, or TTS. A considerable portion of news service copy is now punched out on TTS tape.

When the TTS tape, which is punched by union members of the Commercial Telegraphers' Union, AFL, reaches its destination, it is automatically fed into the linotype machine of the newspaper. The union member of the International Typographical Union, AFL, takes over at this point. A mutual agreement was reached between these two AFL unions many years ago, eliminating any possibility of a jurisdictional dispute.

The new Wall Street Journal edition, soon to be published here in Washington, will receive TTS tape covering complicated market tables, tabular material, and editorial material from its New York office.

By use of the facsimile machine, the U. S. News is able to do its editorial makeup work in Washington and have pages made up and proofread in Dayton, Ohio, the publishing center. As each page is made up in Washington, a picture is sent to Dayton. Eventually, when the type has been set and the page made up, a proof is struck off and facsimiled back to Washington for O. K.

The Commercial Telegraphers' Union, with which I was connected for many years in various executive and administrative capacities, has never opposed labor-saving machinery, particularly when the work displaced has been laborious, monotonous, and health wrecking.

Long ago we adopted the principle that if a message was to be transmitted over a wire, the method or means of transmission was immaterial so long as a union member did the work, and maintained, repaired, and installed the equipment.

We once had a controversy with a well-known brokerage firm, with wires running from New York all over the Nation. He wanted to replace the union operators with girls at about one-half the wages received by the union workers. A 4-day contest was held, by which we demonstrated that at that time the skilled Morse operators could do better than the machines, and more accurately. The number of messages handled was well over 330 per hour, but the wages were still the factor which eventually brought on a strike. The firm lost its business to union competitors and soon went out of business.

Only the other day, it was demonstrated here in Washington on a broker wire that the 100-year-old Morse code, with expert operators at both ends of the wire, can beat the machine. This is not to imply that the machine is not efficient, or faster in a long run. But for fast give-and-take operation on a broker wire, we demonstrated that a customer's order, handed to the operator in Washington, was sent to New York, executed on the stock exchange floor, and the message delivered back to the customer in 19 seconds.

Automation to the telegrapher is acceptable so long as the man follows the job—if there is a job left. If not, then the union asks for the work of installation, adjusting, maintenance, and repair of the equipment, which, of course, is very intricate and subject to local and wire interruptions.

We only ask that our members be given the opportunity to train for this work before the job-eliminating equipment is installed.

The CHAIRMAN. The chairman will also insert in the record at this point a statement from the members of the executive council of the International Plate Printers, Die Stampers, and Engravers Union of North America, A. F. of L., dated October 14, 1955, together with a statement that accompanies it on automation, its impact on banknote printers.

(The information is as follows:)

WASHINGTON PLATE PRINTERS UNION,
Washington, D. C., October 14, 1955.

HON. WRIGHT PATMAN,
Vice Chairman, Joint Committee on the Economic Report,
Senate Office Building, Washington, D. C.

DEAR CONGRESSMAN PATMAN: Recently, we requested an opportunity to testify during your hearings on automation. Realizing that you are extremely busy on this report, we were delighted to be given an opportunity to submit a report. A copy of this report accompanies this letter. The report has been submitted to Mr. William H. Moore, as per his request.

Hoping you will believe that it is important and revealing enough to be read and placed in your hearings, and wishing you all the success and good wishes of our labor organization in your endeavors, we are

Respectfully yours,

HAROLD D. BROCKWELL,
THOMAS G. GILL,
Members of the Executive Council of the International Plate Printers, Die Stampers, and Engravers Union of North America, AFL.

AUTOMATION—ITS IMPACT ON BANKNOTE PRINTERS

Submitted by members of the executive council of the International Plate Printers, Die Stampers, and Engravers of North America

This report is submitted in an endeavor to present the economic impact on craftsmen, and is not to be considered a condemnation of automation. It is an effort to give a picture of how highly skilled craftsmen have been affected by automation of certain printing processes.

Plate printing or the printing of securities from steel engraved plates has been recognized as a highly skilled craft since the days of Paul Revere. It has been utilized by the Government of the United States in the printing of their securities since the inception of the use of currency and postage stamps. The engraving and plate printing of securities is today recognized as the only type of printing that is not vulnerable to counterfeiting. Heretofore, requirements always provided a field for the training and usage of apprentice and journeymen printers. Production and techniques kept pace with progress.

About 5 years ago, a program of automation was launched in the Bureau of Engraving and Printing. Engineers were engaged to develop and install equipment that would raise production. These improvements were developed and proven in the Bureau of Engraving and Printing. It is a matter of congressional record that without the cooperation of these printers, whose suggestions and inventiveness were utilized to a great degree, the outstanding record of the Bureau of Engraving and Printing could not have been achieved.

At the start of this program, each printer required the aid of two female assistants in the performance of his duties. Today, with the development of improvements such as automatic press feeders, automatic polishers, automatic takeoff equipment, nonoffset inks, etc., the daily production of these printers has increased over 100 percent and the jobs of the two female assistants have been eliminated.

In 1952, the Bureau of Engraving and Printing employed 539 journeymen plate printers and 70 apprentice plate printers. After two reductions in force and a new reduction taking place on October 31, 1955, the Bureau will employ less than 300 plate printers. The Bureau has indicated that further reductions will be necessary in 1956 because of expected new technological improvements in the production of postage and revenue stamps. Improved techniques in other production areas has reduced the personnel requirements from over 8,000 employees to less than 4,000.

With an intimate knowledge of the economic standards of the members of our organization, and we believe, must reflect situations in many other like crafts, we are extremely concerned with the effects of automation on our members.

Many of the printers who have been reduced in force have had to accept positions in the Government at less than half of their former salaries in order to protect their retirement rights and because of their age status. A large portion of these men are over 50 years of age and consequently other printing concerns are reluctant to employ them. Most of these printers were recruited from all parts of the country during the past conflicts and have over 13 years of Government service.

In this report we are not trying to condone or condemn automation in industry, but we sincerely believe that a careful study of the impact on the older and skilled workers of industry who cannot adjust themselves must be made. Human values should be considered and a gradual installation of automation would lessen the impact on labor.

We are grateful for this opportunity to give the facts of the effect of automation in our small segment of the country's economy. We must believe it has and will be reflected many times over in the new industrial revolution. We hope that it can be included in your committee's report and read at the hearings.

Respectfully submitted.

Harold D. Brockwell,
Thomas G. Gill,
Members of the Executive Council of the International Plate Printers, Die Stampers, and Engravers Union of North America, AFL.

The Chairman. In addition, to be inserted in the record, a report to the Joint Committee on the Economic Report on the subject of automation, remarks of Clinton August Reams, president of the Reams Research & Development Corp., of New York, N. Y.

(The information is as follows:)

REMARKS OF CLINTON AUGUST REAMS, PRESIDENT, REAMS RESEARCH & DEVELOPMENT, INC., NEW YORK, N. Y.

Subject: Automation.

Automation is a recently coined word, the name of a prominent magazine publication of exceptional promise, but the general application of the term is misleading in concept when applied to all types of machines and apparatus automatic or providing sequential operation. Properly applied, it is the automated tool of the superskilled labor existing at the moment in the United States industry. To a great degree, sensitive measuring and calibrating gages and the tools have made automated production possible and necessary; not the electrical-mechanical appurtenances often credited.

Education of the skilled (and the semiskilled) workmen in our schools, particularly the trade schools (such as Henry Ford Trade School, the technical trade schools in many of the large industrial centers, and the service schools) have produced men with the ideas of practical use that go by the drawing-board stage into the actual automated units. Our big universities have not been producing the men who directly devise and invent these devices and units. However, the university men have been to the forefront in devising processes for the reduction of metals, chemical production, communications equipment, electrical devices and machinery, glass and refractories, special steels, atomic and X-process; all the product of their coordinated effort by teamwork.

It cannot be said that a chemical process is automation even though its integrated batching of materials is automated and the added solutions are measured by flowmeters and regulated automatically. It is the production of the end product from the raw material, or blank, to the finished article, in its true application, a combination of controlled sequential fully automated operations.

Automation challenges in calling for a more specialized education in courses at university level, well grounded in electrical and mechanical, chemical-metallurgical engineering with a 5-year curricula. Study habits and qualifications must be high, those fitted to undertake the work should have a high I. Q. A program should be begun similar to that undertaken for the indoctrination of engineers in the atomic-energy field. Prerequisites should be set at a high level equal to the latter requirement by an official board of educators and industry leaders.

Thus far, the development of the automated devices and process have been the brain children of many engineers who have had a general experience in many basic or related industries over the years. Outstanding have been the problems posed by the automotive, electrical, and glass industries that required the implementation of the production processes with automated means and devices to make to close tolerances and limits products not possible to make beforehand, because of the element of human sensory lack.

Working conditions for labor in plants can be immeasurably improved by the more generalized utilization of automated production. Their rate can be increased more than tenfold with little expense, effort, and planning on the part of management. However, so great a gain must call for labor to contribute a just proportion of their increased piece rate as an allowance for the industry having provided them with the automated-production tool or device.

Automated-production equipment makes possible the better utilization of space in the buildings provided for housing and shelter. With the present high cost of industrial buildings, the advantage to an industry in saving of heating, lighting, and the other attendant services is of great moment.

In this age of intensive specialization, modern production to be termed efficient, must be predicated upon modern equipment, machines, and methods. Automated production best contributes the outstanding development of the machine age. Our industrial economy is geared high but it must not be hobbled by limiting markets, reducing credit, etc., to deter its forward progress. We must expand our markets so that the United States can maintain its present leadership.

Professional awards must be offered by our Government for outstanding accomplishment and discovery and not wasted in so much buying of friendship abroad. Our beloved United States must gird, not with weapons and so many adopted isms as the professional soldiery and politicians would have us to believe—it must be with production means to further us unequivocally on the road to prosperity and peace.

Mr. Henry Ford once inferred: "The more cars I can build, the cheaper I can make them." Many of the automated devices had their inception in Ford plants and the pace still continued, provides the automatic machining of the complicated cylinder block. However, the first step was to cast the cylinder block by semiautomated method in 1938, over 17 years ago.

American labor in these United States can, and will, far outstrip that on any continent, if its members will cooperate with the engineer (and management) in an honest and forthright endeavor to produce for industry a better product by automation. The immediate need is for qualified engineers to devise and plan, for industry to see the need, for labor to cooperate. The rewards are great for us and the United States of America.

An evident need is present to protect ideas and devices in the much-discussed automated category and to bring this pointedly to the attention of those entrusted with framing the laws to protect the security of our United States. There are those who appreciate—as patriots should—the preservation of industrial security to better protect ordnance, special devices, sensitive plans, et cetera—but it is important to protect automated devices and their plans with a like zeal that has been exhibited by many and applied to less important components of secret devices, particularly in the atomic area.

There is a likelihood that automated devices shipped by American manufacturers might be imitated and duplicated in many foreign lands by manufacturers unfriendly to our Nation. We must be on our guard for we cannot continue in this manner to emasculate our native creative effort—as well as waste our resources in supercolossal programs to spend millions of dollars—and emerge other than a weakened nation, a prey for the devoid of right conscience.

Automation has proven conclusively that it provides one of the greatest economic advantages and a protection to the high labor rates paid United States labor, so it must be preserved at all costs by proper safeguards (not created by the military) by the Congress of the United States of America.

Much security has been violated by scientists and technicians in the unwitting disclosure in publications to disseminate information, but in the instance of automation—there is no reason for the continuance, the free press notwithstanding.

A plea for safeguard has not fallen on deaf ears in the past. However, much of significance has been given to matters of little import by many who want security safeguard only to exercise certain rules set forth in a manual.

From the hearings held thus far, the members of this august body must realize there is a duty to extend protection to this segment of industry, that its growth be wholesomely fostered and every advantage provided. This premium of American know-how should be protected by laws.

The CHAIRMAN. Without objection, the subcommittee will stand in recess until 10 o'clock tomorrow morning here in this room.

(Whereupon, at 2:55 p. m., Tuesday, October 25, 1955, the subcommittee recessed until Wednesday, October 26, 1955, at 10 a. m.)

AUTOMATION AND TECHNOLOGICAL CHANGE

WEDNESDAY, OCTOBER 26, 1955

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC STABILIZATION OF THE
JOINT COMMITTEE ON THE ECONOMIC REPORT,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Wright Patman, chairman, presiding.

Present: Representative Wright Patman, chairman of the subcommittee, presiding, and Senator Joseph C. O'Mahoney.

Also present: Staff Economist William H. Moore; Staff Director Grover W. Ensley.

The CHAIRMAN. The subcommittee will please come to order. We have as our witness this morning Mr. Ralph J. Cordiner.

Your company, Mr. Cordiner, is in the position of being a leading producer of electronic controls and automatic devices. But, in the nature of things, it is also a big user of automated items. It may seem to be looking at a small segment of your large operations, but we are particularly interested in hearing from you as to how automatic computing equipment is being put to new uses in your company. I have seen frequent references in the newspaper and magazines about your use of a Univac system with which to control inventories at an installation in Louisville, Ky.

Perhaps you can tell us something about that operation and how it was carried out before the installation of this system.

We are delighted to have you, sir. You may proceed in your own way.

STATEMENT OF RALPH J. CORDINER, PRESIDENT, GENERAL ELECTRIC CO., ACCOMPANIED BY RAY H. LUEBBE, VICE PRESIDENT AND GENERAL COUNSEL, AND ROBERT L. FEGLEY, PUBLIC RELATIONS SERVICES DIVISION

Mr. CORDINER. Thank you.

May I first present my two associates here at the table with me. On my right is Mr. Ray Luebbe, who is vice president of the company, in charge of public relations, and our general counsel; and second to my right is Mr. Robert Fegley, who has done much of the research and prepared much of the material on which I will testify this morning.

The CHAIRMAN. We must not overlook the name of the company, General Electric.

Mr. CORDINER. The name of the company is General Electric.

General Electric is pleased to have this opportunity to present its view on automation and technological change to the Subcommittee on Economic Stabilization.

We are not only a user, as you said in your introduction, but more importantly, a designer and manufacturer of equipment associated with automation. Thus we have had experience in this field which may prove helpful to you and to the American public.

It is important that the public have an informed picture of the effects of automation and technological change on our national life, because everyone has a personal stake in this progress. Frequently one reads statements which give lip service to the obvious benefits of automation, but go on to exaggerate the problems of adjustment until they make automation appear to be a public menace. Automation is not a menacing development. It is, in fact, a concept which has already raised the Nation's standard of living and has had a stimulating and stabilizing effect on the economy. It will continue to have this welcome effect in the future.

Like most witnesses in these hearings, I feel obliged to establish, briefly, what I understand this term "automation" to mean.

WHAT IS AUTOMATION

For practical purposes in planning manufacturing facilities, General Electric defines automation as "continuous automatic production," largely in the sense of linking together already highly mechanized individual operations. Automation is a way of work based on the concept of production as a continuous flow, rather than processing by intermittent batches of work.

There are those who try to make automation a catchall term to apply to every improvement, whether new or thoroughly familiar, that occurs in a factory or office. It is important to recognize that automation is only one phase in the process of technological progress, a natural evolutionary step in man's continuing effort to use the discoveries of science in getting the world's work done.

The "flow" concept of automation is most easily applied in the processing of liquids, gases, and energy such as electric energy. Thus, in the chemical, petroleum, and electric utility industries you will find a high degree of automation already in existence.

For several decades, our engineers have also developed electric drives with feedback controls for the continuous, increasingly automatic production of materials that can be produced in a continuous strip or web, such as paper, cloth, steel, rubber, and plastics. In parts of these processes, automation is quite well advanced.

In recent years we have seen increased efforts to apply the principles of continuous flow and automaticity to the production of separate pieces or products. Here, you are likely to find the greatest progress in the manufacture of simple, standardized items, usually small ones. Among our approximately 40,000 suppliers, we find many small companies that have done a superb job of mechanization and automation. They thrive on the fact that simple, standard items are easier to produce by automatic techniques than complex and variable products. Nevertheless, we may expect a step-by-step progress toward greater automation even in the industries producing fairly complex products.

In the office and laboratory too, we may expect to see more speedy and automatic processing of data—which might be considered under the heading of automation. In this area, the giant computers have caught the popular imagination. Their potential value in helping man to extend the scope of his knowledge, and the things he can dare to do, is greater than we can comprehend at this time. General Electric has been pioneering in the use of computers in scientific, engineering, accounting, and marketing work. In your letter inviting me to testify before this subcommittee, you asked that we give you a report and evaluation of our experience with computers at Louisville and elsewhere.

I have such a report for you, but since it is rather detailed, I would prefer to enter it in the record as a separate statement, at the conclusion of this testimony on automation and technological change.

The CHAIRMAN. It will be entered into the record.

Mr. CORDINER. Thank you.

(The supplementary statement on computers appears at the end of Mr. Cordiner's testimony, as an extension of his remarks.)

Mr. CORDINER. Thus, in the factory and in the office, you could say that progress toward greater automation is nothing new; only the expression "automation" is new.

Technological change in industry is a gradual process. Most products are first made by hand, or with hand tools. Then industry mechanizes: It introduces machines for some parts of the process, although many hand operations usually remain. As the economics of the situation warrant, the machines are made more and more automatic. Finally, where we can do it technically and where economic considerations warrant the investment, we link together parts of the process to achieve more continuous and automatic operation. As industry moves its operations up this scale toward automation, there is a greater demand for more highly trained people to handle the larger responsibilities.

Most of industry is still in the lower mechanization stage. There are literally millions of hand operations in manufacturing today. Highly skilled mechanists, for example, usually spend much of their time and effort placing material in machines, and removing the material. Only part of their time is used as skilled machinists. There are many other wasteful and burdensome hand operations that add to the ultimate cost of goods going to the consumer. This situation makes two comments appropriate:

1. American industry has a challenging opportunity to increase its productivity, reduce the cost of goods, and increase the real wealth and purchasing power of all Americans—by using every feasible application of the automation concept all along the line from factory to customer. We will at the same time be taking the danger and dullness and drudgery out of industry, and giving people more satisfying work to do, at higher pay for higher skills.

2. This will be a step-by-step process. I am told that the staff of your committee forecasts that the product of the worker and his machine in the country's private economy will increase 2.8 percent per year from 1953 to 1965, and General Electric's forecasts are in approximate agreement. This is slightly less than the 3-percent increase of the postwar years, and a little higher than the long-term average rate of 2.1 percent a year since 1910.

In the years ahead, our guess is that 90 percent of the technological changes in American industry, including General Electric, will be the familiar process of increased mechanization and electrification, along with improvements in manufacturing layout, product design, material selection, data processing, marketing, management methods, and a host of other techniques to make human work more productive—which has been a major preoccupation of man ever since the invention of the wheel.

With this background on the nature of automation and technological change, let us evaluate their future effect on the economy.

GENERAL ELECTRIC'S VIEWS ON AUTOMATION

Let me first state General Electric's views on automation and technological change, and then I will present the evidence supporting these views.

1. Technological progress is necessary in order to maintain our national security.
2. It is necessary if we are to continue to raise the American standard of living even at the same rate as in the last decade. It is even more urgent if we are to accelerate the rate of progress.
3. Technological progress is also necessary from the point of view of individual companies; those companies, large or small, which continually modernize in order to serve their customers better, will prosper in our competitive economic system.
4. Progress toward greater mechanization and automation is in the best interests of all the groups that business must serve—customers, share owners, employees, suppliers, and the public.
5. Technological change is a gradual, evolutionary process which creates employment and exerts a stimulating and stabilizing effect on the economy. This can and will continue as long as business has the incentives and freedom to grow, and to create new products and industries.
6. The benefits of mechanization and automation are so profound—and so urgently needed—that we must encourage those companies that push the advances which make industry more productive.

Now let me present the evidence supporting these views.

AUTOMATION AND THE NATIONAL DEFENSE

First, the importance of technological progress to our national defense.

Many of the key items of military equipment today, such as radar, gunfire control systems, guided missiles, and atomic weapons, are themselves products of automation principles. These military developments have spurred industrial technology; but even more important, continuing progress in industrial technology is essential as a source of knowledge for further improving the Nation's military equipment.

For example, during World War II our industrial engineers helped design radical new systems of aircraft armament in which the aerial gunner had pushbutton control over his guns, and even had computers to help him aim the guns. In coming up with the gunfire control systems for the B–29, the A–26, the B–36, and other airplanes, the engineers used circuits and equipments originally developed for industrial use. The amplidyne generator in the B–29 was originally developed for the steel industry. Thyratron tubes—very important in the B–36 armament—were originally industrial electronic tubes developed for the paper and resistance welding industries. The totally new approach in electric generating systems developed for the B–29 was directly based on our industrial experience.

Thus continuing advances in industrial technology are vital to military technology.

My other point is that our margin of safety in modern arms depends on continuously increasing the productivity of American industry, which produces them.

For example, the United States could not even consider a radar defense system if it did not have highly productive electronics and communications industries to design and produce the necessary elements in the huge quantities required.

Another example is jet engines. When the Korean war broke out, the Air Force needed thousands of jet engines as fast as possible. By applying the principles of mechanization and automation in our Evendale, Ohio, plant, we were able to boost our monthly production of engines 1,200 percent. These J–47 jet engines powered the F–86 Sabres which scored a 14–to–1 edge over the Communist jet aircraft in the Korean war.

As an illustration of technical progress, the thrust of these engines has been increased 23 percent through design improvements, and the present J–47 engine has an allowable flying time of 1,200 hours, compared to 150 hours 5 years ago.

In spite of the cost of making more than 20,000 design improvements, we were able progressively to reduce the price by about $15,000 per engine. This resulted in a total saving to the taxpayers, from cost reductions on jet engines, of about $4 to $6 million.

This illustrates how technological progress is essential to our national defense, and effects important savings for the taxpayer.

AUTOMATION AND THE STANDARD OF LIVING

But we are a peaceful nation, and far more important is the necessity to improve our technology in order to increase our standard of living. The new abundance which is possible through greater automation is one of our major weapons in waging peace.

According to our company's estimates, and they are in line with the estimates of your committee's staff, the United States will require about 40 percent more goods and services by 1965, with only 14 percent more people in the labor force. To produce 40 percent more goods and services with only 14 percent more people, either everyone must work harder and longer, which is neither a realistic nor a good solution, or industry must be encouraged to invest in more productive machinery and methods. Faster progress in the newer field of automation seems to us to be the only available solution to this problem, particularly in situations where we have exhausted the known economic possibilities in the more familiar field of simple mechanization.

From all that we can foresee, it appears that there will be a shortage of men and women to fill the work opportunities in the coming decade.

After 1965, when the proportion of labor force to the total population increases, some feel that there may be a trend toward the shorter workweek. But our feeling is that the demand for goods may rise so fast in the 1970's that we still be hard put to produce enough goods to satisfy the market on a 40-hour basis, and the American public will choose more goods in preference to a shorter workweek.

AUTOMATION IS IN BEST INTERESTS OF ALL

As Plutarch said, "He who would divine the future must study the past." With that in mind, let us look at a case history of an industry where the so-called automation revolution has already taken place—namely, the production and distribution of electric power.

When you flip the light switch on the wall, you start up one of the most completely automated processes in the world. Electricity cannot be made and stored in advance. It is made and delivered immediately, to your order, at the speed of light. To make such an incredible process safe, reliable, and low priced, it has been made increasingly automatic.

From your light switch, back through wires, meters, transformers, substations, switchgear, generators, turbines, right back to the fuel sources such as the coal pile, gas, oil, or waterhead, there are hundreds of self-supervising and self-regulating devices, many of them developed by General Electric engineers and scientists over the past 75 years.

For example, (chart 1) the first completely automatic hydroelectric station, with no attendants, was installed in 1917. This one was installed in 1922 at Wilmington, Vt.

The first (chart 2) completely automatic substation was installed in 1914, by the Elgin & Belvidere Electric Co. Prior to this, there were usually three attendants at the substation to read meters and turn switches, and obviously they could not deal with interruptions or load changes with the same speed as automatic equipment.

Here is the granddaddy (chart 3) of modern computers, a d.-c. network analyzer built by our engineers in 1915 to reduce the amount of pencil-and-paper calculation required to design power systems. The principles now referred to as automation have been familiar in the electrical industry for many years.

Now, has this progressively automated process of producing electricity injured the consumer and put people out of work?

To the contrary, our highly automatic network of power has created a huge electrical industry employing 2,600,000 people, and it underlies America's productive capacity and her standard of living.

Here is what has happened (chart 4) to the price of electricity to the residential consumer, as the electric utilities increased their efficiency. The price has gone down steadily since 1900.

Since 1939, the cost of living (chart 5) has gone up 93 percent, but the cost of residential electricity has gone down 2 percent, as measured by the Consumer Price Index. This is one way that the consumer benefits from an industry that has progressively employed the techniques of mechanization and automation.

As the price dropped (chart 6), volume rose—the classic formula in industries which aggressively improve their methods of production and distribution. Sales of electricity have doubled every decade since the turn of the century. In the past 10 years, the use of electricity has gone up 2½ times, with tremendous effect on industry and the home.

In 1954, the average worker (chart 7) in manufacturing had 17,900 kilowatt-hours of electrical energy to help him get his work done—the equivalent, in human energy, of 250 assistants. This is one of the important reasons why our country is so much more productive than the rest of the world.

Here is what the automation of power production (chart 8) has meant to the housewife. Because electricity costs so little, the average home uses more than 2,550 kilowatt-hours a year, the energy equivalent of 36 servants. A fully electrified home uses 30,000 kilowatt-hours a year—equivalent to 450 servants.

To design, build, sell (chart 9), and service the equipment to produce and use this low-cost power, there has come into being a major industry, today employing 2,600,000 people. This includes 395,000 in the utilities, 1,400,000 in electrical manufacturing, 155,000 in electrical contracting, 510,000 in the electrical wholesale and retail trade, and 140,000 in electrical service and repair. Notice that employment in the total industry has more than doubled since 1939, with increases in every segment of the industry. This chart illustrates the importance of looking at a whole industry to assess the full effect of mechanization and automation. The highly automatic production and distribution of power requires "only" 395,000 people, but the process itself creates employment opportunities for 6½ times as many people. And the really incalculable effect is on users of electricity—the industries that are powered, the cities that are lighted, and the homes that are made more livable by low-cost electric power.

The increasing use of electricity provides one of the important stabilizers in our expanding economy.

This seems, in fact, to be a characteristic phenomenon. The manufacturing industries which have gone the furthest in automation, and the industries which supply equipment for automation, are the ones in which employment is rising the fastest. This would include the communications, electrical, machinery, chemical, rubber, automobile, and petroleum industries. The static, unchanging industries are not the sources of growth in employment in our economy.

In the General Electric Co., we have been mechanizing, improving methods, and automating as fast as we can economically develop and apply the required technology. We are proud of it, and plan to continue to make our company a more productive element of society. I should like briefly to present a case history of the results of 16 years of unremitting efforts to introduce greater mechanization and automation is a single company, so that we can judge the effect on all groups that our company is set up to serve—namely, customers, share owners, employees, suppliers, and the public. We have chosen the year 1939 as our base because it provides a long enough time span for both good and bad effects to show up; because it is considered by economists to be something like a normal year; and because it was a year when the new techniques of industrial electronics were just beginning to emerge.

Here is how consumers (chart 10) shared in the benefits of increasing automation in General Electric. On a weighted average, General Electric prices have gone up 57 percent, while the price of all commodities, except farm and food, rose 102 percent. That difference represents money saved by consumers. In the same period, we have had an increase of 144 percent in the cost of our basic raw materials, and a 177 percent increase in average earnings and benefits paid to our employees.

The housewife (chart 11) buying many of our consumer products will find a lower price tag now than she did in 1950, even though the products have been improved. For example, the 1950 refrigerator, with 8 cubic feet capacity, cost $329.95. Today's comparable refrigerator, with 9.2 cubic feet capacity, sells for $228. A 12-inch television set in 1950 cost $230.90. Today you can get the comparable 21-inch set for $199.95. If you are satisfied with a 14-inch TV set, you can buy it for $99.95. Much of this price reduction can be attributed to our investment in more automatic production.

For the 341,728 owners (chart 12) of General Electric, their equity in the company—their money in the business—has tripled, mostly through retained earnings. But their percentage return on the equity has stayed about the same. Dividends remain at about 13 percent of equity.

Employment at General Electric (chart 13) has been increasing since 1939 at a rate 6 times as fast as the country as a whole.

The number of employees (chart 14) at General Electric has tripled from 71,500 in 1939 to 230,000 today, including those employed on atomic projects. Thus 158,500 General Electric employees hold positions that did not exist in 1939—certainly evidence that technological progress, together with skillful marketing, creates new employment opportunities.

Employee compensation (chart 15) and other benefits paid by the company have grown more than 8½ times, from $145 million in 1939 to an estimated $1,257,200,000 in 1955. Translating that into individual terms (chart 16), in 1939 the average General Electric employee earned $2,028 a year, including the value of benefit programs. Today a General Electric position is worth $5,613 a year, on the average, and that includes a splendid package of pension, insurance, vacation, holiday, and other benefits providing better economic security. By the way, our pension plan began in 1912, and we have had group life insurance since 1920. When you take out the effect of inflation, since 1939 the average employee has had a 44-percent increase in real purchasing power, except for taxes. This increase also reflects the general upgrading of jobs as we advance toward greater automation. Work is cleaner, safer, and more pleasant in modern factories and offices.

General Electric's progress (chart 17) from technological advance has been shared by other businesses, large and small.

Since 1939, our payments for materials, supplies, and services have gone up more than 10 times. At the present time we have about 40,000 suppliers, most of them small businesses, and many of them aggressively mechanizing and automating their operations. This flow of business to other companies of course creates growing employment opportunities. In addition, roughly 400,000 small companies gain all or part of their income from selling and servicing our products.

The public and its representative, Government, have also shared in the benefits of automation in two principal ways. First, there are the improved product values and new products to which I have already referred. Second, there is the effect on the national defense, and the tax savings that automation makes possible such as the $4 to $6 million savings in jet-engine costs.

Results such as these, in General Electric and in the electrical industry, would not have been possible without mechanization and automation although other factors have obviously contributed. It is in the setting of these immense benefits to consumers, share owners, employees, suppliers, and the public that we must consider the human problems which go along with technological advance.

ADJUSTING TO TECHNOLOGICAL CHANGE

Automation usually involves laborsaving machinery and methods, just as simple mechanization does. And, theoretically, in individual instances it would appear that people would be laid off because they are no longer needed on a particular job. But in the General Electric Co., due to the gradual nature of the improvements and the small ratio of improvements to the continuing base of operations in the plant by unchanged methods, it is seldom that a person is put out of work by an improvement.

Naturally, General Electric management puts extra thought and effort into minimizing such layoffs, by having other work ready for the employees involved whenever possible. Good planning for automation includes planning for the all-important human problems as well as the mechanical and financial problems.

The fear that automation will move too swiftly for orderly adjustment overlooks the powerful factors which govern the pace of technological advance.

First of all, there is the difficulty of actually thinking through and designing workable automation developments.

Second, the financial risks involved must be evaluated, and they are serious enough to make a businessman weigh carefully each investment in automation.

And, third, management must work out some way to assure the wider, steadier market which will justify the investment in new machinery and methods.

At General Electric we try to plan any substantial technological changes in such a way that normal attrition of our work force—the people who quit, retire, or die—will absorb the shift in employment.

The factor of normal employee turnover has not been adequately appreciated in most discussions of automation. In the past 12 months, General Electric has hired about 40,000 new employees to replace those who quit, died, retired, or whose employment terminated for reasons other than lack of work. In the same period, at least 33,000 of our employees changed jobs within the company because of promotions, technological changes, and the normal internal shifts of the work force due to lack of work in one area. This is how General Electric, and probably industry generally, takes care of the short-term adjustments which have caused so much concern in these hearings.

Naturally, the company provides any training required to enable employees to handle new assignments. Most of this training is informal in nature, and is done by individual supervisors on the job or through vestibule training schools that run from 1 to 2 weeks, in preparation for a specific kind of work. In addition, our company conducts more than a thousand courses in factory skills and at least 500 courses at its various locations for professional, technical, and semitechnical personnel in the areas of finance, manufacturing, engineering, supervision and management, and marketing. We estimate that in an average year 1 out of every 8 General Electric people at all levels of the organization takes advantage of company-conducted courses.

We estimate that we spend on the order of 35 to 40 million dollars a year to train or retrain our employees. This figure includes idle time and scrap and waste resulting from inexperience and the training needed.

Such statistics give you some measure of General Electric's willingness and ability to handle whatever retraining activities are required by technological advance. In addition, we have an expanding program of support for education generally, which, in 1956, will include $1,400,000 in scholarships, grants, and fellowships.

If, in spite of the best planning we can do, some people are temporarily unemployed because of technological change, both industry and government have recognized a responsibility to help families through any such periods of transition, as they seek new employment. The States provide unemployment compensation, and in all but two States the entire cost is borne by employers. These rates of compensation are constantly under study, and are revised as needed to fit the realities of the times. Just this year, 34 States enacted new laws increasing unemployment-compensation benefits, which our company thoroughly believes in and supports.

But even more important is the role of industry, and of automation itself, in making new employment available. Generally speaking, there are four sources of new employment that arise from automation and technological change.

HOW TECHNOLOGICAL PROGRESS CREATES EMPLOYMENT

1. Technological progress sets off a sort of chain reaction of economic growth: more productive machines reduce costs and prices; this increases volume of business, creating a need for more workers. This period between the installation of new machines and the build-up of business is generally very short. It has to be, or the company could not afford to invest in the machinery.

The reverse is also true. If a company fails to modernize, it will lose business, and a few workers can be employed. A company owes it to its customers, share owners, and employees to modernize and thus remain competitive.

2. The service industries provide new employment. Our economy, as it progresses toward greater automation, spends less of its effort, proportionately, in making things, and more in selling, servicing, and using things. In 1947 purchase of services accounted for 31 cents of the consumer dollar. Today, the figure is 36 cents—up 16 percent in 8 years. Technological progress creates more leisure and wealth for cultural and educational activities. Hobbies, sports, travel, enter-

tainment, and retail trade are increasingly important sources of employment.

3. The industries supplying automation and technological advance also create new employment opportunities. We have what might be described as a "bow wave" theory of technological employment. When a boat moves at high speed, the water it displaces piles up in front of the boat, in what is called the bow wave. In an analogous manner, there is a wave of new employment opportunities that runs in front of automation and technological change—the employment involved in designing, selling, building, and installing the new machinery and controls, along with the new buildings required. In addition, there is additional employment required to maintain and service the equipment after it is installed, and to sell and service its increased output.

This bow wave of technological employment has not yet been adequately studied, statistically, and deserves the attention of interested economists.

4. Entire new industries, employing thousands, are created by the new automation technologies.

The great chemical, petroleum, and electrical industries, among the fastest-growing industries in America, simply could not exist without mechanization and automation. You cannot make chemicals, gasoline, and electricity by hand.

On the horizon we see an atomic energy industry, a transistor and semiconductor industry, an industry for the production of the supermetals like titanium and zirconium, and even the manmade diamonds that came out of the General Electric Research Laboratory this year. These and many others will grow into sizable areas of employment. Advanced techniques make such difficult products possible, and, of course, create new employment opportunities.

In General Electric, 70,000 of our employees work on new types of products we did not make in 1939, such as television, jet engines, chemical products, and atomic energy. Not only research, but advanced manufacturing methods, make such new products possible.

The computer, extending man's mental capacities beyond anything we can imagine, will create fantastic increases in human knowledge, and thus vastly increase the number of things we can make and enjoy.

Based on our experience with these machines, which I will discuss in a separate statement, it may well be that the computer-derived technologies will be a major source of new employment in the 1960's and 1970's, and they will keep us perpetually short of manpower to take advantage of our opportunities.

Thus, we have four factors at work to provide new and increased employment opportunities:

1. The chain reaction of lower costs, higher volume, and higher employment.
2. The expanding service industries.
3. The automation-supply industries.
4. The new products and industries growing out of the new technologies.

There are two additional factors which indicate that automation will have a stabilizing effect on the national economy and employment.

Automation programs require long-range, detailed planning of capital investment, and the pursuit of these plans regardless of temporary ups and downs in annual sales. Thus investment in automation will increasingly serve as a general stabilizer in our economy.

As automation and mechanization are introduced in a company's operations, fixed costs go up. With high investments in machinery, industry has one more incentive to keep those machines running as steadily as possible. This provides a great stimulus for better planning, more professional marketing, and all the other techniques for maintaining steady demand and employment.

Now, when you couple these factors with the simple fact that the Nation's appetite for goods in the next decade will rise faster than the number of people available to produce them, you can see why we feel that automation and other technological progress are necessary and beneficial, and that they exert a stimulating and stabilizing effect on the economy.

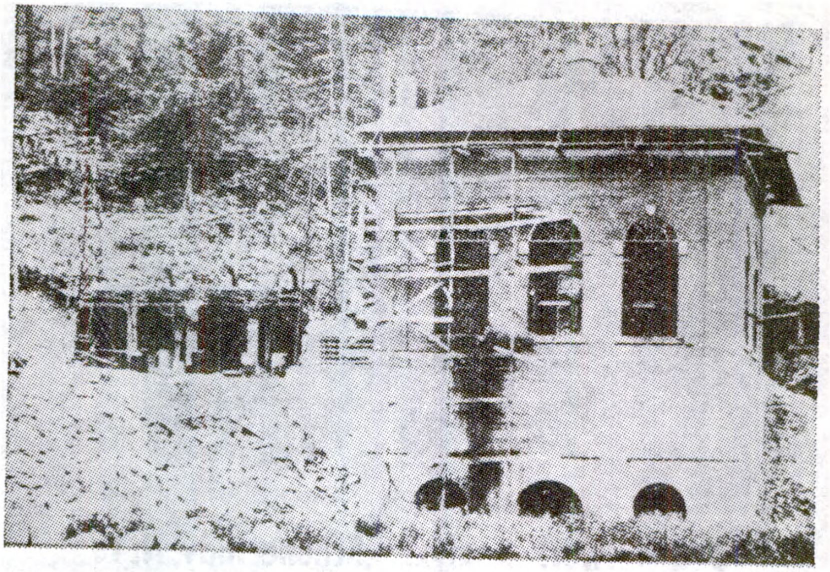
On balance, it appears that automation is part of the general picture of research and progress which has characterized our strikingly successful American competitive business system. It is in the public interest to have tax policies and other economic policies which will encourage business to invest in research and greater productivity, because these are the sources of new employment and national wealth. They are the real and substantial sources of increased purchasing power throughout the economy, not only among the 25 percent of the labor force engaged in manufacturing, but among all the families in America.

Concepts like automation are at once an expression and an instrument of the vitality of the American people. They serve us well in our continuing search for better ways to work and live.

The CHAIRMAN. Thank you very much. That is a very interesting statement. It has many thought-provoking questions, many constructive suggestions, and we will insert in the record all the charts and statements that you have attached to your statement. The whole thing will then be in the record.

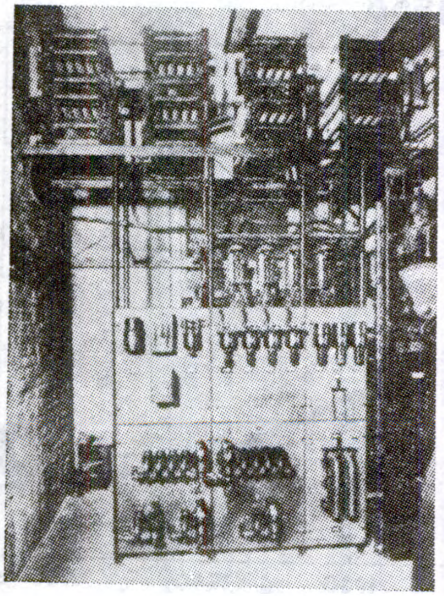
(The material referred to is as follows:)

AUTOMATIC HYDROELECTRIC STATION, 1922



New England Power Company, Wilmington, Vt.

CHART 1

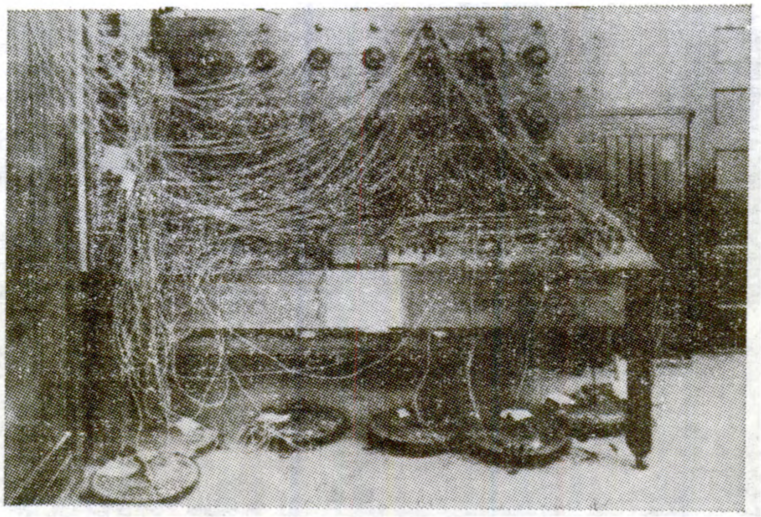


FIRST AUTOMATIC SUBSTATION 1914

Elgin & Belvidere Electric Company

CHART 2

EARLY GENERAL ELECTRIC COMPUTER 1915



D-C Network Analyzer, Schenectady, N.Y.

CHART 3

COST OF RESIDENTIAL ELECTRICITY 1900-1954

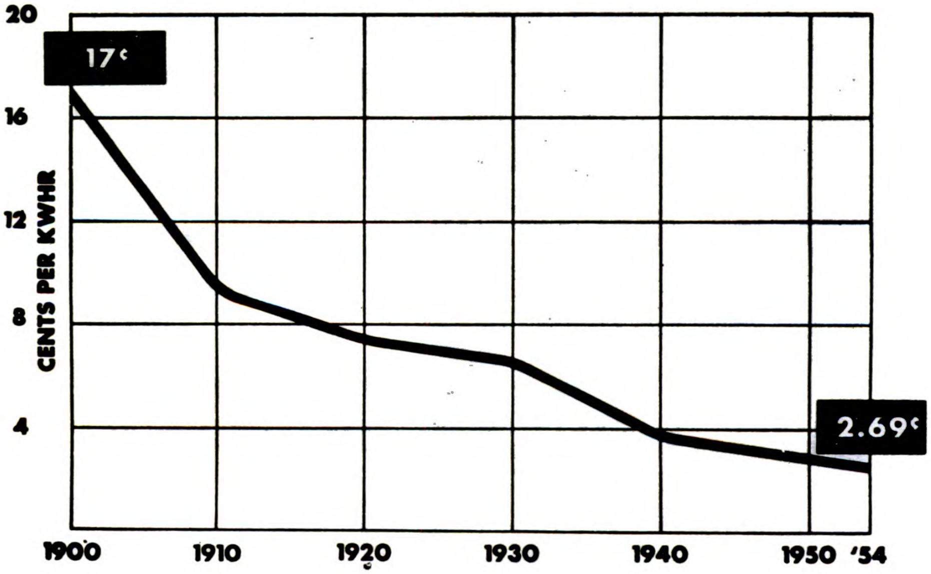
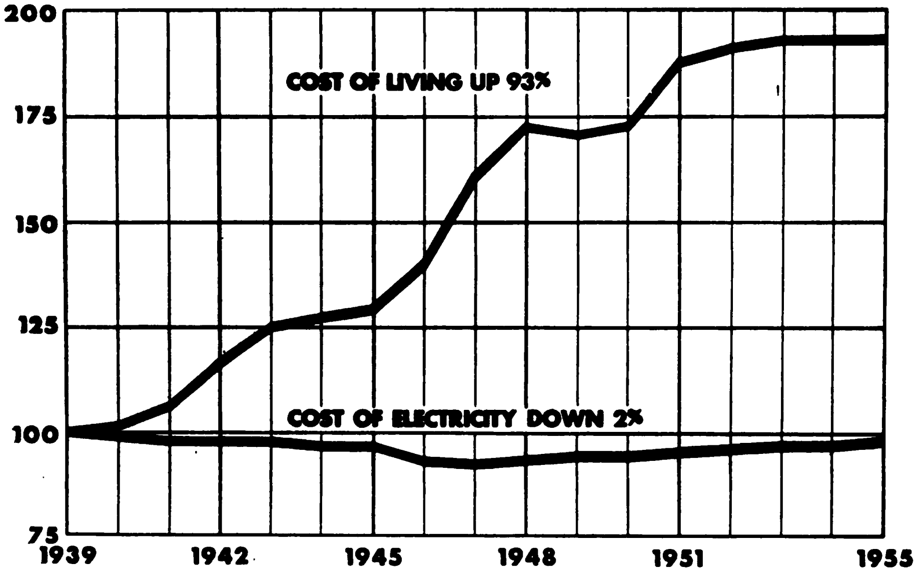
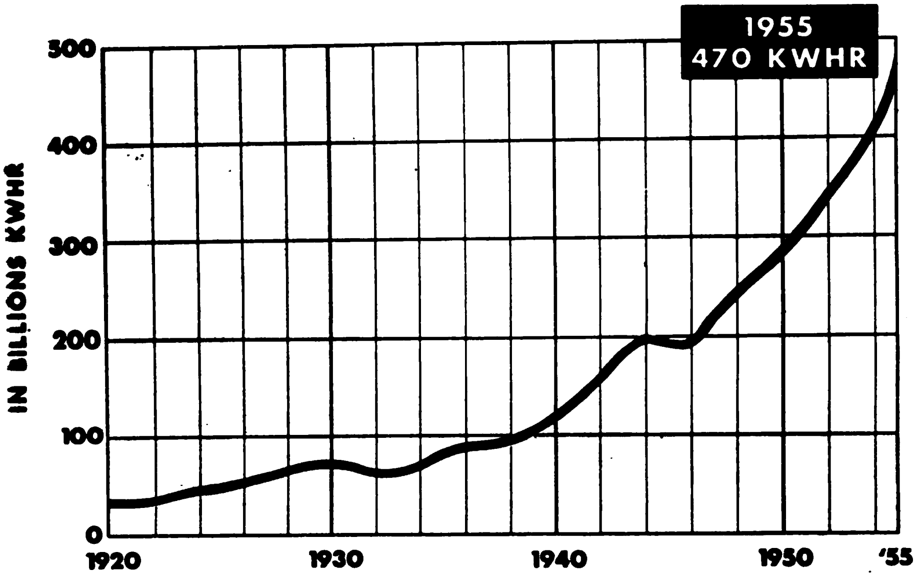


CHART 4



COST OF RESIDENTIAL ELECTRICITY VS. COST LIVING (CONSUMERS PRICE INDEX, 1939=100)

CHART 5



SALES OF ELECTRICITY IN U.S.

CHART 6

ELECTRICITY USED BY AVERAGE WORKER (ANNUALLY)

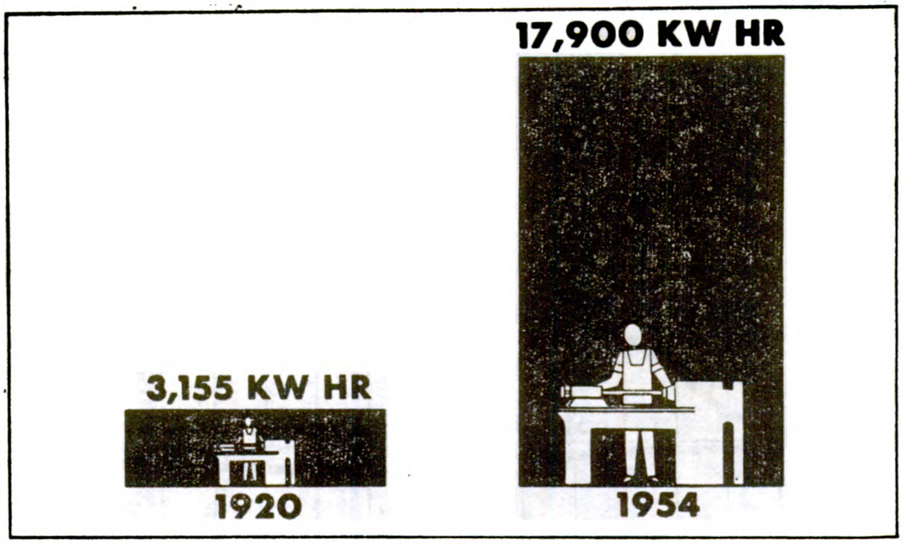


CHART 7

HOME USE OF ELECTRICITY UP 7½ TIMES

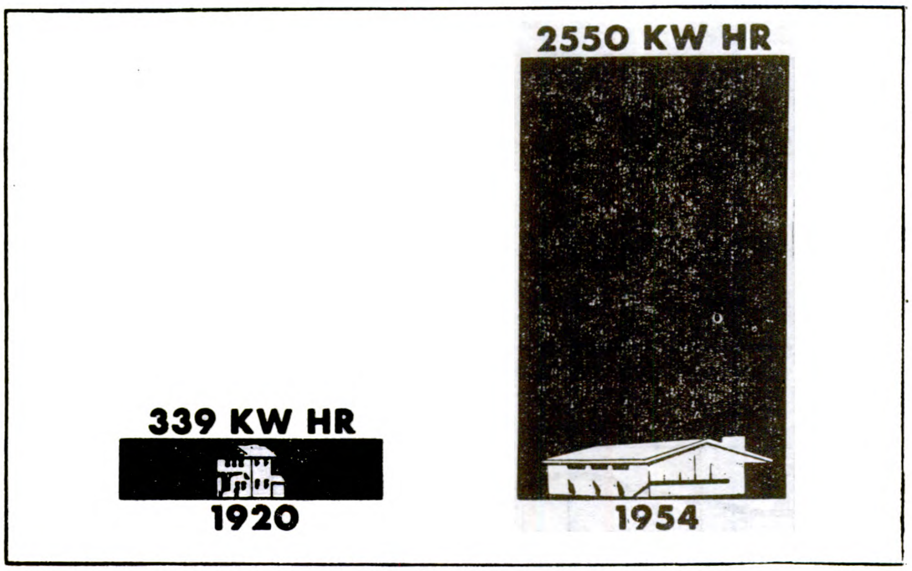


CHART 8

EMPLOYMENT IN TOTAL ELECTRICAL INDUSTRY

INDUSTRY COMPONENT	1939	1954
UTILITY	284,000	395,000
MANUFACTURING	500,000	1,400,000
CONTRACTING	58,000	155,000
WHOLESALE AND RETAIL TRADE	258,000	510,000
SERVICE TRADES	28,000	140,000
TOTAL	1,128,000	2,600,000

CHART 9

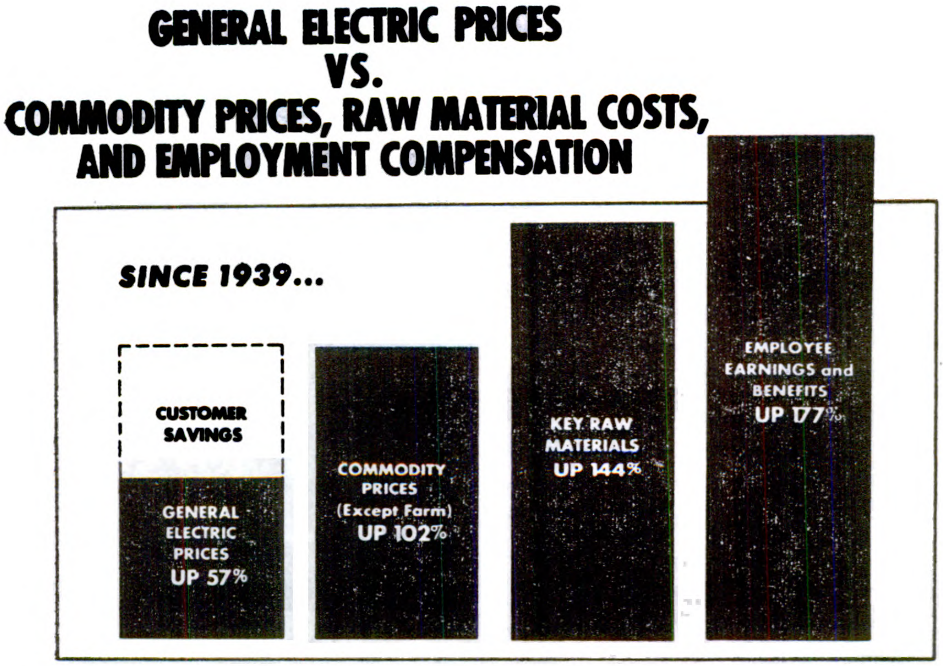


CHART 10

PRICE REDUCTIONS IN GENERAL ELECTRIC CONSUMER PRODUCTS

	1950	1955
VACUUM CLEANER	89.95	79.95
TELEVISION	230.90 (12-INCH SCREEN)	199.95 (21-INCH SCREEN)
AUTOMATIC BLANKET	52.95	34.95
REFRIGERATOR	329.95 (8 CU. FT.)	228.00 (9.2 CU. FT.)
AUTOMATIC WASHER	394.95	279.95
AUTOMATIC DRYER	249.95	189.95

CHART 11

RETURN ON EQUITY
(FOR 341,728 OWNERS OF GENERAL ELECTRIC)

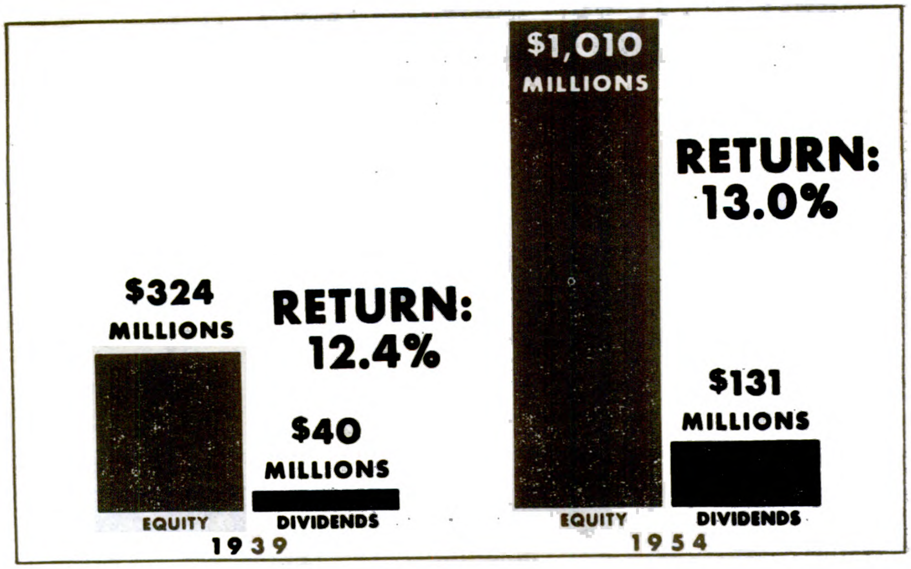


CHART 12

GROWTH IN TOTAL EMPLOYMENT
1939-1955

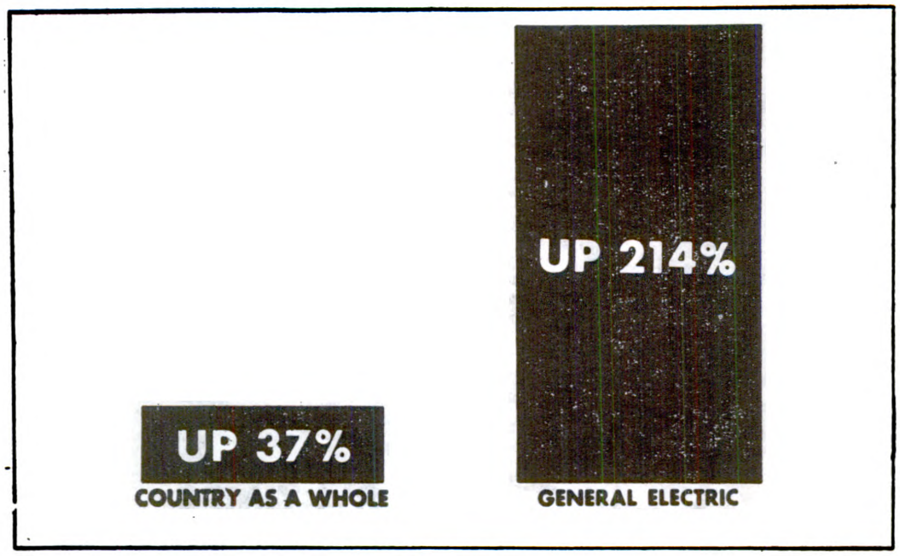


CHART 13

GENERAL ELECTRIC EMPLOYEES

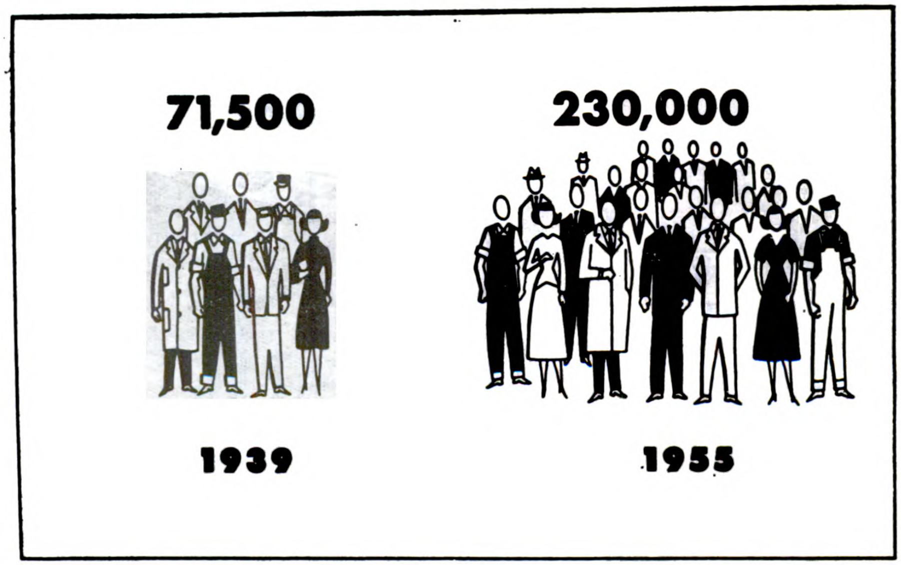


CHART 14

EMPLOYEE COMPENSATION AND BENEFITS

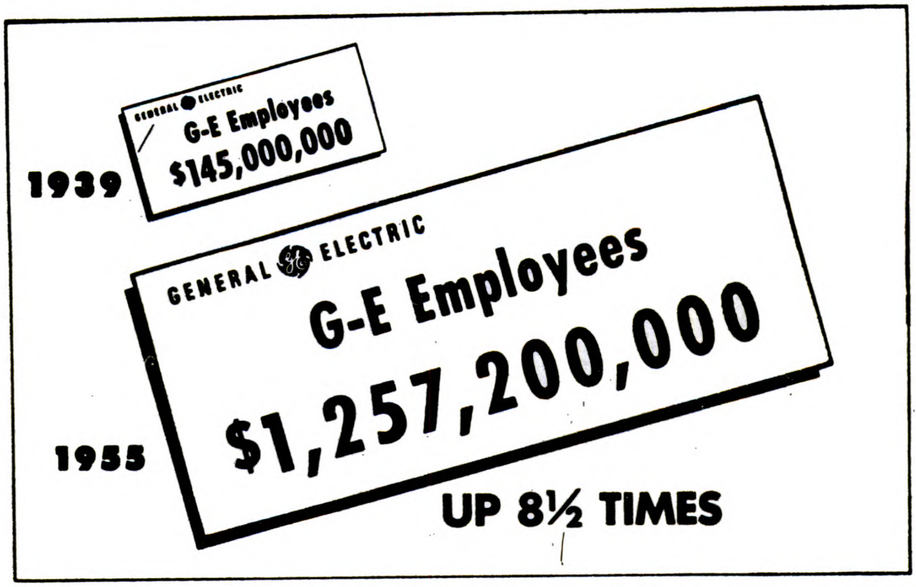


CHART 15

AVERAGE ANNUAL EARNINGS GENERAL ELECTRIC EMPLOYEES (INCLUDING BENEFITS)

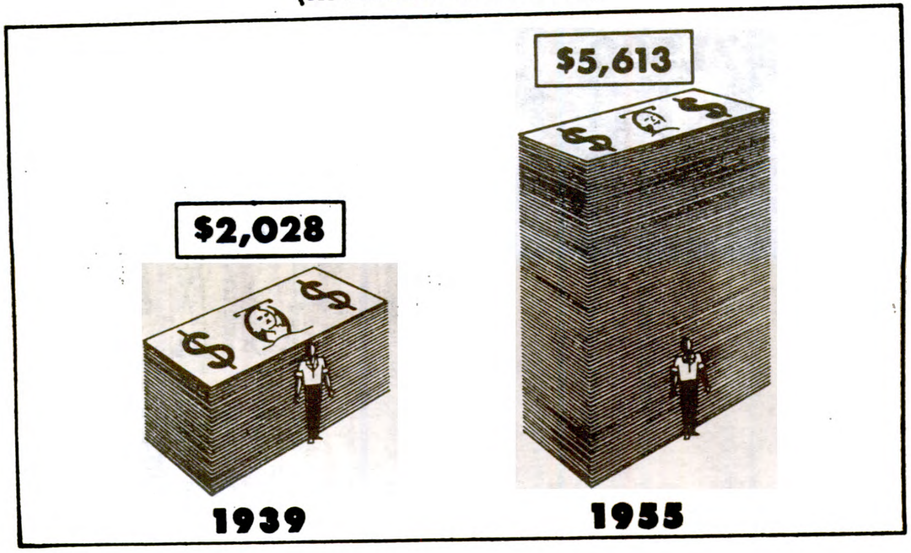


CHART 16

PAYMENTS FOR MATERIALS AND SUPPLIES UP 10 TIMES

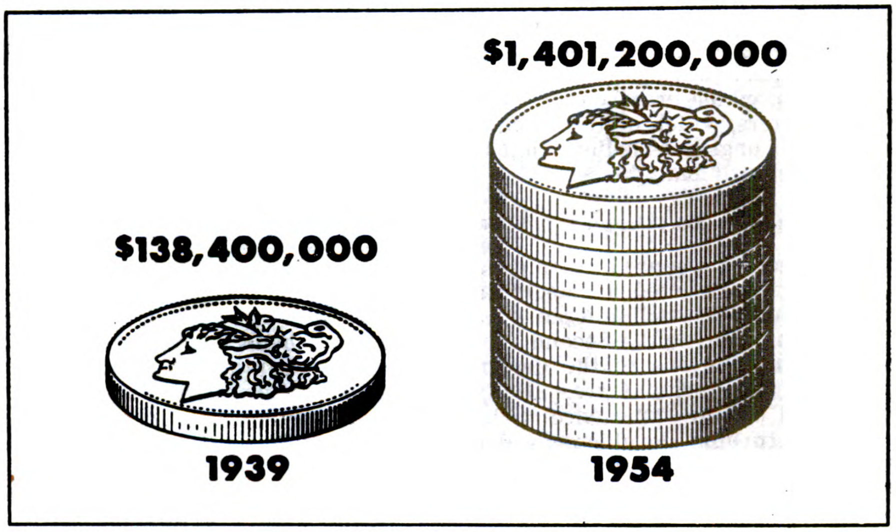


CHART 17

STATEMENT ON EXPERIENCE WITH COMPUTERS IN GENERAL ELECTRIC

(By Ralph J. Cordiner, president, General Electric Co.)

Your committee has expressed an interest in hearing a report of General Electric's experience with the large electronic computers, particularly the installations at Louisville, Ky., and Evendale, Ohio, which have received considerable publicity in the past year. We are happy to present this information, which may be helpful in evaluating some of the possible future effects of the use of electronic computers in industry.

In June 1952 General Electric installed its first of the large electronic computers—an IBM 701—in the aircraft gas turbine development department in Evendale, Ohio. It is used chiefly for engineering calculations, and serves many of our product departments in addition to the aircraft gas turbine division.

In 1954, we began operation of a Sperry-Rand UNIVAC System, at Appliance Park, in Louisville, Ky. This computer is used for data processing in accounting, manufacturing, and marketing.

We have been sufficiently pleased with the results to expand our plans for such large electronic computers. An IBM 702 has just been installed at the atomic products operation which we operate at Hanford, Wash., for business data processing and some scientific applications.

In the coming year, we plan to install 5 more large electronic computers—4 for engineering and 1 for business data processing.

We also have many small- and medium-sized companies, both digital and analog, many of which we have built ourselves. It is our feeling that the medium-sized computers will have the greatest usefulness for business in the immediate future.

Altogether, we have 121 computers in current use. Of these 83 are used for engineering purposes, and 38 are used for data processing. Of the total 23 computers which we have ordered or intend to order, 19 are to be used for data-processing purposes and 4 for engineering.

I think these statistics, by themselves, tell you that our company considers the computer a very important tool of modern business, in research, engineering, manufacturing, marketing, and accounting.

If there is one idea which I would like to leave with you today, it is that the computer represents an important extension of the powers of the mind of man. When the history of our age is written, I think it will record three profoundly important technological developments:

Nuclear energy, which tremendously increases the amount of energy available to do the world's work;

Automation, which greatly increases man's ability to use tools;

And computers, which multiply man's ability to do mental work.

Some of our engineers believe that of these three, the computer will bring the greatest benefit to man.

COMPUTERS FOR RESEARCH AND ENGINEERING

Our engineers have used computing mechanisms for a long time. As early as 1915, they constructed an electrical analyzer on the analog principle, to reduce the amount of pencil-and-paper calculations that were necessary for power-system design. During the Second World War, onr Schenectady computers made important contributions to the design of electronic equipment for the Armed Forces. But the effects of present-day large electronic computers might best be demonstrated by our experience with the IBM 701 which was installed in our aircraft gas turbine development department in 1952, and about which the committee has asked us to report.

At the present time, this machine is operating around the clock, 7 days a week. It performs repetitive and program calculations not only for the engineering and test areas within the Evendale plants; it also receives problems over telephone transceiver circuits from our plants in Schenectady, N. Y., and Lynn, Mass. Other departments send in problems by mail. The problems range, I am told, from the most abstruse nonlinear partial differential equations of supersonic aerodynamics to simple reduction of test data in tremendous quantities.

For the most part, these are calculations that could be done without the aid of computers, or would be so expensive that we could not afford to do them.

For example, there are certain calculations which will determine the best nozzle and bucket angles in a low-pressure steam turbine. These calculations take from 15 minutes to 1 hour to do on the computer at Evendale. It is not practical to do this calculation by hand since it would require from 1 to 3 years of continuous, error-free hand calculation for each turbine. Obviously, before we had the computer we had to rely on less exact data.

Guided and unguided missiles would be practically unthinkable without computers to calculate their trajectory. We will have to use computers in our work on the earth satellite project, for example.

The computers have greatly speeded the development of jet engine and airframe designs, which are so important to our national security. It costs many months and many millions of dollars to build and test an experimental jet engine, in order to try out a single new design. Now the computer enables us to explore and test thousands of design possibilities on paper, before we proceed to production. This has meant very swift advances in engine design, as well as great savings to the taxpayers. And when we consider that other nations are engaged in the race with the United States for air supremacy, you see the importance of such computer techniques to our national security.

Now as to the effect of this computer in Evendale on employment.

In 1952, when the machine was installed, we employed approximately 30 young women in that department for manual calculation. Today we employ about 20 in that capacity and 40 more as programers for the computer. These 40 are more highly paid and more highly trained than were the 1952 employees; they are in much greater demand elsewhere in industry, and 8 of them have professional standing. In addition, about 50 male employees analyze and program problems, and operate the night shifts.

The computers are not substitutes for engineers. In fact, a glance at the New York Times "Help Wanted" ads will reassure you that the very companies which are using computers are the ones who are also increasing their engineering staffs, including General Electric. These computers help to create so much more scientific information, and introduce so many more technical possibilities, that we need more engineers to put the new information to work. I think this is

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the pattern of the future: the computer opens up scientific possibilities that were unthinkable before, and will make possible new products and industries that we cannot possibly foresee. It is our feeling that these computer-derived technologies will be a major source of new employment in the coming decades.

To the people in our Evendale plant, the computer is extremely important to their continued employment. Our engineers with their computers must continue to come up with ever-better jet engine designs to serve the needs of our military and commercial customers, so that we will have employment for the more than 12,000 General Electric employees in Evendale. Here is the real impact of the computer on employment stability: not simply providing employment for 80 more people in the computer section but maintaining employment for more than 12,000 people in our Evendale plant, and helping to create new industries that will some day employ thousands more.

COMPUTERS FOR BUSINESS DATA PROCESSING

As in the case of computers for engineering, our company has been using computers and business machines for a long time in the processing of business data, such as information relating to accounting, marketing, and purchasing. The large computer at Louisville is simply the next logical step in a continuous effort to cope with the ever-increasing paperwork of modern business. At the same time, I would not want to underestimate the long-term importance of this pioneer installation. The things we are learning to do with computers at Louisville can ultimately bring about important reductions in the cost of producing and delivering goods to the ultimate consumer, and can result in greater stability in production and employment.

Our major appliance division, with headquarters at Louisville, consists of five separate departments which manufacture refrigerators, ranges and water heaters, home laundry equipment, electric sinks and dishwashers, and room air conditioners. The departments vary in size from 700 to 5,000 employees. The computer installation provides service for all five departments.

For our initial venture into business applications of this computer, we selected four existing procedures having substantial amounts of clerical and routine effort. These four areas were payroll, material control, order service and billing, and general and cost acounting.

In October 1954 we began to use the computer in payroll accounting for the hourly employees in Louisville. Following an established plan of conversion of departments, we are now paying approximately 8,500 hourly employees using the computer payroll system.

Modern payroll calculations are quite complex. In the processing from gross to net pay, the computer calculates Federal, State, and social security taxes and other deductions. The computer prints the paychecks, the gross pay register, the deductions and net pay register, quarterly, semiannual, and annual tax reports, and all necessary accounting entries and employee reports. Developing such a program for computer processing involves a tremendous amount of meticulous work—far more than we realized in the beginning.

The reason is that the computer has no built-in intelligence with respect to how to do payrolls or any other operations. These must all be set out in detail, translated into the language of the computer (which in this case is digital arithmetic), and then converted into the kind of operations which the computer can do even on so repetitive and so routine a task as payroll. The amount of initial work required in order to make the computer do this type of work is large and requires the effort of highly trained people, not only with knowledge of payroll but also knowledge of the computer itself.

Now, what have been the results of our Louisville experiments in payroll accounting?

Most important, we learned that the job can be done—but that there are plenty of "bugs" to be ironed out, and the system must be introduced and tested step by step.

In some of our early calculations regarding this installation, we estimated that the payroll work would be done in 2 hours a week and that all 4 applications would require about 10 hours. Actually payroll is taking about 20 hours of computer time per week and we are only beginning to undertake the other 3 applications.

One of these, the material control program, has been operating in one of the departments for the past 3 months. Other departments are scheduled to be converted within the next few months. This material control program produces

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new information that we did not have before, which enables us to reduce our investment in inventories and avoid interruptions of production and employment due to lack of supplies.

The third project in our original plan, general and cost accounting, has reached the point where bookkeeping for two of the departments has been substantially mechanized. Here our objective is to issue all financial reports within the week following the close of the month. This will include a profit and loss statement, balance sheet, expense statements for all functional areas, together with supplementary details where required. Such faster, more complete data for management will enable us to do a better job of planning and cost control, which of course eventuates in more even employment and lower prices to consumers.

Billing, which is the fourth and last project in our original Louisville plan, is still in the design stage. We hope to convert to automatic billing, step by step, in the coming months.

Now, these four applications are really the simplest applications, and not necessarily the most important in the long run. For example, using the computer, we have also developed a system of marketing reports which promises to improve our ability to plan production and distribution. Briefly, these reports give the status of sales and inventories, in units, for all appliances at the three levels of distribution—factory, wholesale, and retail. It also estimates unit sales for the year based on present sales volume, seasonal characteristics, and any other variables injected into the formula by Marketing Research. From these projections, the computer calculates the required levels of inventory and production schedules to support such a sales volume. Exploratory and factual information of such accuracy and timeliness has never been available to management before.

We are also experimenting with the use of this computer for preparation of budgets and forecasts, and for factory scheduling and machine loading.

From this we can see that the most important value derived from business-data computers lies in making available completely new and timely information which will help business to reduce the cost of producing and distributing goods through its ability to plan more stable production and employment.

We should remember that most of the clerical routines involved in such operations as payroll and cost accounting have been mechanized for 10 or 15 years. In shifting from one kind of machine to another, there is not a great deal of difference in the number of clerical workers required for this type of work. The important point is that the larger, higher-speed machines enable us to explore new possibilities in the area of business information, and to obtain data that we could not economically obtain before. Such new and exploratory work now employs about 35 skilled technicians at the Louisville installation.

We feel that the use of computers in accounting, manufacturing, and marketing will follow the pattern established by our Evendale computer in engineering. As we learn how to use computers, we will give them more work to do. This will require more people to prepare the problems for the computers, more people to operate them, and more people to interpret and use the results produced. What is involved here is a gradual shift of employment, to higher-grade and more productive work.

Even more important is that the computer at Louisville will cut our cost of doing business, keep us competitive in the very competitive market for appliances, and give our customers better product values.

To sum up:

1. The computer is an important invention which extends the capacity of the human mind.
2. The computer is essential to our national defense, in the advanced design of military equipment.
3. The computer will help business to produce better products at lower cost.
4. By providing better and more timely information for management, the computer will help to improve the stability of employment through better planning.
5. The computer-derived technologies will create new products and new industries which will be major sources of new employment in the coming years.

The CHAIRMAN. You mentioned no surplus of labor before 1970, I believe.

Mr. CORDINER. 1965.

The CHAIRMAN. And you think we will then have to begin considering what we should do about a surplus of labor. You don't think we should be concerned about that right now.

Mr. CORDINER. I made the statement that with a need or desire for 40 percent increase in production, and only an increase of 14 percent in the labor force between now and 1965, in my opinion, there would be a continuing shortage of labor for the next 10 years.

When you get to 1965, and then for the ensuing decade, I said I thought the American people at the market place would make the decision as to whether they wanted more services, more products, or a shorter workweek, and, personally—and this is my personal viewpoint—I don't think you are going to have an excess of labor beyond 1965. I think the demands of the citizens everywhere are so instatiable that if we get on with this job of technological progress that the condition we now have can well continue beyond 1965.

The CHAIRMAN. We have been told that in the short run there will be some displacements. I assume that you agree that in certain areas we may have. When a machine takes the place of a number of people something must be done about those people. Do you agree to that, Mr. Cordiner?

Mr. CORDINER. I can only speak authoritatively with regard to General Electric obviously.

The CHAIRMAN. You probably have experienced it, because your concern is one of the biggest in the Nation. You have probably just been running in the front and making these adjustments, but I assume that you have run into it many times?

Mr. CORDINER. I would like to reply this way: The responsibility for planning automation or other technological changes calls for careful study to avoid hardship on employees and to keep layoffs at a minimum by providing other work for the employees involved.

At General Electric, because of our rapidly increasing employment overall, plus normal attrition of people who quit, die, or retire, we are able to handle such shifts in employment without much difficulty.

In addition, we pay our share of unemployment compensation for people who are out of work in the States where we operate. We are heartily in favor of unemployment compensation as a fair way of helping out those who for any reason are out of work.

I would make the further observation to your question that technological improvements or automation come so gradually that intelligent management—and I assure you they all have this common interest—can plan these changes so that, as I said in my prepared statement, based on our actual experience to date, it is very seldom that that ever occurs, and we don't see it ahead of us. You train the employees and upgrade them, as I said in my text, where 1 out of 8 employees, about 12 percent of them, are continually taking training courses at company expense to upgrade them for new jobs.

The CHAIRMAN. That brings out the point that I was leading up to. Do you consider it a company and industry, No. 1, responsibility to retrain the people and put them in other jobs?

Mr. CORDINER. I completely agree.

The CHAIRMAN. You mentioned in your statement that:

> **The States provide unemployment compensation. In all but two States the cost is borne by the employer.**

Which of the two States do not have unemployment compensation?

Mr. CORDINER. In all States except Alabama and New Jersey the employer bears the total cost of unemployment compensation. Then I said that in 1955, this last year, 34 States, including Hawaii, Alaska, the District of Columba, enacted new laws increasing benefits.

The CHAIRMAN. I am very much interested in your statement about your training program. I am glad to know that you are doing so much in that direction. I hope all other companies do the same thing, and take as much interest as GE is doing in that respect.

It has been brought to our attention more than once that we are behind Russia in at least one respect. We will graduate next year about 27,000 engineers. Russia will graduate about 50,000 engineers. Next year, 1956, we will graduate about 50,000 technicians, and Russia will graduate about 1,600,000 technicians. Would you like to make any comment on that, Mr. Cordiner?

Mr. CORDINER. Yes, I would.

I have here an ad that you may have seen, that we are addressing to the public, and we are pointing out just exactly what you describe; that all industry should have had, this last year, 37,000 engineers, and we had but 21,500. In this advertisement we list five ways to help solve the critical shortage of engineers.

One is to help guide young people's careers, when they are at high school level, so that if they have the aptitude, they will take math and science. Second, is to bring businessmen and educators together. Third, is to help the schools financially, referred to in my testimony. (We think that is an obligation of companies as well as individuals.) Fourth, is to educate employees on the job. And fifth, is to encourage self-development.

Now, even doing all those things, we are temporarily going to be short of technically trained people. I think that through the use of computers, and automation, as I covered in the other statement that I am filing with your committee, you will see that we have been able to lengthen the arm and the mind, so to speak, of the technical employee and to make him far more productive. I think that is one of the great contributions that is coming with computers and with automation.

The CHAIRMAN. Dr. Brunetti, of General Mills, named 23 skilled and technical jobs that are created by reason of automation, and in the filling of none of them is a college education required. One would have to have a high school education, I assume. That question didn't come up.

Are you trying to interest students finishing high school now or after they finish, say, 1 or 2 years in college?

Mr. CORDINER. This advertising and the direct contact we have through our summer training course of math and science teachers that we have been carrying on with Purdue, Rensselaer, Case School of Applied Science, and Union College now for 6 or 7 years, are trying to encourage the high-school teacher to suggest to students with the aptitudes that, about their sophomore year, they might well consider taking mathematics and science and going on to college for a technical career.

Now, beyond making those suggestions, and doing this educational work, we haven't been effective enough, except in the frequent advertising messages that we run in educational magazines, and in the public press. Here we are trying to tell of the great opportunity directly ahead if one has the ability to be an engineer.

My personal opinion is that the law of supply and demand is going to work. You see in the Sunday papers so many competitive ads for engineers that these young students are going to come to realize they can sell their talents at a higher price with a technical education than otherwise.

The CHAIRMAN. You are hiring a lot of the high-school teachers yourself, aren't you, Mr. Cordiner, teaching math and science?

Mr. CORDINER. Well, I would have to look that up and I will give you a report on it. My impression is that we are not intentionally.

The CHAIRMAN. I don't say that you are intending to do it to the detriment of the country, but you are hiring a lot of them. Naturally, you would.

Mr. CORDINER. I am not so sure. I would like to check that and give you a report. I am rather doubtful if we do. We try to avoid, if we can, any raiding activity of the faculties of schools or colleges, unless some such individual applies; then we clear it back through channels, to find out if he is going to go out of the teaching profession anyway. Then we very much would like to have him consider General Electric.

(The material referred to follows:)

General Electric does not recruit teachers from either secondary schools or colleges, because we feel that the quality of the technical personnel we do hire, now and in the future, depends very much on the presence of good teachers in the schools. Although we do not keep statistical records of this particular matter—the number of former teachers on our payroll—our people in charge of technical manpower development tell me that there is actually a significant amount of transfer from General Electric to the schools. For example, a number of our finest engineers have, with our encouragement, become faculty members or administrators of engineering colleges. Among these are:

Karl McEachron, dean of engineering, Case Institute of Technology
B. Richard Teare, dean of engineering and science, Carnegie Institute of Technology
Loyal V. Bewley, dean of engineering, Lehigh University
F. C. Lindvall, professor of chemical engineering, California Institute of Technology
H. A. Peterson, professor and head of engineering, University of Wisconsin
Wesley Dunlap, Webster professor of engineering, Massachusetts Institute of Technology

In addition, General Electric pays fees for specialized consulting services of many outstanding technical teachers in the colleges. Such an arrangement enables them to supplement their teaching income, and reduces the temptation for them to leave their academic work—where we feel they can make their greatest contribution both to our country and to General Electric.

With respect to high-school teachers, since 1945 we have sponsored a program of summer fellowships for science and mathematics teachers designed to help them keep up with the latest developments in the technical fields. Through this program, 1,450 teachers have studied at leading colleges, and heightened both their enthusiasm and their qualifications for science and mathematics teaching.

Teachers do sometimes come to us and apply for jobs, usually with the purpose of leaving teaching to enter industry. If they are qualified, and if they plan to leave teaching anyway, we may hire them. However, we do not recruit them and our personnel people assure me that the number of teachers among our total technical employees is, to the best of their knowledge, very small.

General Electric believes that the quality of teaching—technical and otherwise—is of great importance to all of industry, and will become even more important in the years ahead. As citizens, we must do all we can to assure that the teaching profession will be able to attract and hold those who have the gift of teaching.

The CHAIRMAN. I was very much interested in your statement here:

> In addition, our company conducts more than a thousand courses in factory skills and at least 500 courses in its various locations for professional, technical, and similar technical personnel in areas of finance, manufacturing, engineering, supervision, mining, and marketing. We estimate that in an average year 1 out of every 8 GE people, at all levels in the organization, takes advantage of the company-conducted courses.

You are spending about $35 million to $40 million a year to train or retrain these employees?

Mr. CORDINER. That is right.

The CHAIRMAN. You are taking care of all of your people who are displaced for any reason. You retrain them and put them in another job. You have been successful in doing that in the past?

Mr. CORDINER. I would like to be able to say we have been 100 percent successful. I don't think we have always been 100 percent successful. We give that opportunity to the employee, to follow the procedure that I am describing. We do spend this kind of money, but sometimes individuals do not have the mental aptitude.

To the point that you made earlier, we have employees that have not had the advantage of a high-school education, or science taught at the high-school level for these more intricate, highly skilled jobs. We can't always upgrade them. In the majority of cases, we can and try to. The person that does not have the mental aptitude is not likely to be discharged as far as GE is concerned. We have so many diverse jobs requiring semiskills, or little skill, that we can usually take care of that individual.

The CHAIRMAN. I presume, too, that a lot of them want to retire?

Mr. CORDINER. Oh, yes; we have voluntary retirement at 60, and mandatory retirement at 65, with a very liberal, generous pension plan.

The CHAIRMAN. That applies to all, officials, employees?

Mr. CORDINER. Yes; we are all exactly on the same formula from the lowest paid to the highest paid employee.

The CHAIRMAN. Mr. Moore, would you like to ask any questions?

Mr. MOORE. Do you feel that the advance of science in this country, or our pushing ahead in scientific invention, is impeded by this shortage of technicians which we have been talking about?

Mr. CORDINER. I would think yes, to the degree that the industrial firms do not use computers and other types of automatic equipment to lengthen the mental capacity of those engineers. Yes. I would say that is true.

Mr. MOORE. Would you feel that these Russian technicians—10 or 20 times as many—are capable of making a proportionately larger contribution toward pushing the scientific frontier than our smaller number?

Mr. CORDINER. No; I wouldn't. Of course, during the Korean war, as you will all remember, there were countless inferences in the press that the MIG jet airplane was more effective than United States jet planes, but when the war was over, the batting average was 14 to 1, in favor of our own technology, our own scientific approach.

Now, we have got to keep pushing out all the time, if that is your question, Dr. Moore, but as far as I know of military production or technical ability presently, here in 1955, even with fewer technical graduates I think that the United States will take care of itself.

Mr. MOORE. You suggested the possibility that the law of supply and demand might bring about some adjustment in this field in time. If people are to make the decision at the sophomore level in high school, it would mean that it would be 5, 6, or more years before this progress would begin to show.

Mr. CORDINER. That is right. There will be a shortage, to your point, in the next 5 or 6 years, but we are already seeing a far higher percentage of the high school students in their sophomore, junior, and senior years, turning to scientific subjects. Within the last 4 or 5 years that has happened, and that is very encouraging.

Mr. MOORE. The Sunday sections of the metropolitan papers are amazing in demonstrating an apparent demand for engineers. That, of course, is simply competitive bidding at work.

Mr. CORDINER. That is right, and it is very high. The engineer graduating today, particularly with a master's degree or a doctor's degree, is in an excellent competitive position to sell his services.

Mr. MOORE. But does he feel impelled to change work every Monday after reading those Sunday papers?

Mr. CORDINER. No. There is some of that going on, too. I will have to admit that we probably are all guilty, in part, on that front as we get new projects. I would say the average engineer decides, first, in what kind of research or advance engineering he is interested; second, he takes a look at the industry; and finally he selects a company. Our experience is that you don't get too much turnover once you get them aboard; your real problem is to get them aboard.

Mr. MOORE. Do you have any answer on how to organize a research team in the scientific field? How do you get the best work out of these people?

Mr. CORDINER. We organize our work, of course, through a very deep and penetrating decentralized operation. We have about 26 operating divisions. I refer to a couple of them here. You asked about Louisville. That is our major appliance division, and the jet engine activity is at Evandale, Ohio, just out of Cincinnati.

In our case, to the best of our ability, we give this engineer about 2 years of rotating engineering assignments when he comes aboard. First of all, as a graduate, he is exposed to many areas of the company, and then he makes the selection as to where he thinks he would like to work. Usually his selection involves not only location but a product. To the best of our ability, we adjust ourselves to his desires.

When an engineer or scientist goes to work in his area, he is given a project and the necessary leadership. We find our most effective method is to give the engineer an opportunity to work on that in which he is interested and can make a contribution. Now you can't always do that, but our most brilliant results come from young and old engineers or scientists grouped together on the technical frontier that they are trying to explore, to wit, the diamond result.

The average age of those scientists, I think, was about 37. About 4 or 5 years ago they went to the head of the Research Laboratory and said they thought they could make diamonds. I got into the picture because it required a sizable amount of money. We were not interested in the diamond venture as such, other than for borz—products for cutting tools. We were more interested in exploring the results of metals at temperatures and pressures that would correspond to

250 miles deep under the crust of the earth. Well, once these 5 young fellows had made diamonds, which happened around the turn of last year, they had no more interest in that subject. We have moved the diamond project into a production area. These scientists have gone now into the intriguing question of what happens to certain metals and alloys at temperatures and pressures far beyond anything we have ever known, and some very interesting and dramatic things are going to result from that kind of work.

People with that kind of mind are dedicated to pushing back the frontier, and to the extent that we can, we give them that opportunity. Maybe that is why we have been successful in our technological advances. We have not tried to regiment people.

Mr. MOORE. This doesn't relate to engineers only, but I was rather interested in a statement that you made that in the last 12 months General Electric has hired 40,000 new employees to replace those who quit, died, or retired. That would be about 1 in 6?

Mr. CORDINER. Yes.

Mr. MOORE. Perhaps I can anticipate your answer, but General Electric isn't unusual in your opinion in that respect?

Mr. CORDINER. Our turnover rate is at the lower end of the average of industry, but what I was indicating to your committee is the mobility of the work force, which is one of the great things we have in this country.

Some people don't like to work in Schnectady, Fort Wayne, or wherever they are, and they go elsewhere. They should be given that opportunity.

The CHAIRMAN. Mr. Ensley.

Mr. ENSLEY. One more question with respect to education.

During the 1930's, the Federal Government supported higher education through a number of programs, including huge construction projects, of the PWA variety and the NYA work programs. During the last decade the GI bill of rights, of course, provided substantial Federal funds for scholarships for higher education, and the armed services provided a certain amount of education. Those latter two programs are tapering off rapidly.

Would you feel that the Federal Government in order to not retrogress in this field should provide some kind of a bold, new scholarship program for higher education?

Mr. CORDINER. Well, I wouldn't be a very informed witness on that subject. I know that the President appointed a committee some time back to study that subject. I think it is under the chairmanship of Neil McElroy, as I understand. I understand in about 2 months they are going to report out some conclusions.

Knowing some of the members who are serving on that committee, I would think there would be some very provocative recommendations made. Directly answering your question, I would rather defer that until I have the advantage of their findings and their research. Mine would be merely a personal observation, and if I can make that——

Mr. ENSLEY. A very valuable one.

Mr. CORDINER. I think there is also a very deep and penetrating problem that the average student graduate of a school—any of us in this room—may fail to recognize: While we are on the campus we only pay about half the cost of our education. Until you can awaken the graduates to the fact that they owe their school, particularly the privately endowed schools, for that other half, and until they pay that debt afterward, I think you will have this as a continuing problem. When you get into the philosophical area as to what would happen if the Governmert were to pay or subsidize education——

Mr. ENSLEY. We have been doing it the last 20 years.

Mr. CORDINER. I wouldn't be a very good witness on that one. I admit that I wouldn't be sufficiently informed; after I see the pros and cons of this committee report that is coming out on education, then I think all of us as citizens are going to have to face up to the decision.

Mr. ENSLEY. A question with respect to your chart 11, "Price Reductions in GE Consumer Products."

This illustrates the way in which the consumers have benefited from technological development and mass production?

Mr. CORDINER. That is right.

Mr. ENSLEY. Do you have similar data on, say, the common, 100-watt light bulb, which all of us use so many of?

Mr. CORDINER. Well, this is from memory. My recollection is that when we first started making incandescent lamps that they sold for about a cent a watt, and a 100-watt lamp bulb sold for about a dollar. We have considerably reduced the price to where I think presently—I have got it here, my associates have just pointed out that we reduced the price to where a 60-watt light bulb was 40 cents in 1922, and it went down to 10 cents in 1942. I don't have the 100-watt price, but it is in that general range.

Mr. ENSLEY. The 60-watt is 10 cents today?

Mr. CORDINER. It has gone up. I think it went down to 10 cents in 1942. Presently it is 19 cents, but it was 40 cents in 1922.

Now, you might properly say, what put it up? Our chart 10 indicates our prices generally have gone up 57 percent while industry prices generally have gone up over 100 percent, which is true as of now. That latter is a Government figure. The increased cost of brass, labor, raw materials, being well over 100 percent has meant that contrary to what we would like to do we have had to reflect some of those increased costs, which we don't quarrel with, in the price to the consumer.

I would still say that you don't buy anything in American industry for 19 cents, anything, that represents so much technology, automation, and ingenuity as that electric-light bulb that we think lasts so long that we don't get the replacement.

Mr. ENSLEY. Is it your position that technological development is going on in the manufacture of the bulb in these years but has not been going on as rapidly as has the increased cost of labor and materials that has gone into it?

Mr. CORDINER. That is right. In the last 13 years we pushed our price up 47 percent for 100-watt bulbs. Had we not been carrying on studies in technology our prices would have gone up more than 100 percent, if that answers your question.

Mr. ENSLEY. If in reviewing your testimony there are any additional facts you would like to put into the record with respect to the common light bulb, I would like to see them.

Mr. CORDINER. I would like to give you the exact figures.

The CHAIRMAN. You may revise or extend your remarks. You see, all Members of Congress are allowed that privilege.

Mr. CORDINER. Thank you, sir.

(The following was subsequently received for the record:)

I have ascertained the figures on lamp prices, and they are as follows:

In 1922, the 100-watt incandescent lamp cost $1. Today it is priced at 22 cents.

In 1922, the 60-watt incandescent lamp cost 40 cents. Today it is priced at 19 cents.

The greatest advance in incandescent lamp design and in automation of our lamp-manufacturing processes took place in the twenties and the thirties. As a result of these great improvements we were able to get the price for a 60-watt bulb down as low as 10 cents in 1942. Since that time the costs of basic raw materials and labor have more than doubled. We have not been able to absorb these increases because the manufacture of incandescent lamps was already so highly developed that further automation has had relatively little effect. Thus, there have been unavoidable price increases since 1942.

In the late thirties there was another important technical development which brought the consumer even more light for his money: the development of the fluorescent lamp.

In 1939, a 40-watt fluorescent lamp cost $2.80. Today it is priced at $1.15 and lasts 4 times as long.

Meanwhile, our laboratories are experimenting with new light sources that will someday result in even more light for the consumer's dollar.

The CHAIRMAN. We are indebted to you for the fine contribution you have made to our study. We appreciate it very much.

Mr. CORDINER. We appreciate being here. Thank you.

The CHAIRMAN. Mr. Kennedy is our next witness. Mr. W. P. Kennedy.

Mr. Kennedy, you are president of the Brotherhood of Railway Trainmen, which is the largest operating union in the railroad industry. Its members are employed in both train and yard service on all railroads in the United States and Canada. Mr. Kennedy is a former railroad man, himself, who entered the service as a brakeman, with the Great Northern Railway in 1909, and 1911 became a switchman, with the Canadian Pacific. He was employed as switchman later by the Chicago, Milwaukee, and still maintains seniority rights at the Minneapolis terminal.

While most of the impact of automation in the railroad industry thus far appears to be confined to the yard service, it appears that automatic control may be extended to the train service as well.

Mr. Kennedy is therefore in a position to provide this subcommittee with the facts and information regarding the broad impact of technological change in the railroad industry.

Mr. Kennedy, we are delighted to have you, and you may proceed in your own way.

Mr. KENNEDY. Thank you.

STATEMENT OF W. P. KENNEDY, PRESIDENT, BROTHERHOOD OF RAILROAD TRAINMEN, ACCOMPANIED BY DEWEY ANDERSON, DIRECTOR OF THE PUBLIC AFFAIRS INSTITUTE OF WASHINGTON, AND EMIL ZUKLIN, SECRETARY TO MR. KENNEDY

Mr. KENNEDY. First, on my right, is Mr. Dewey Anderson, director of the Public Affairs Institute of Washington, and on my left is Emil Zuklin, my secretary.

The CHAIRMAN. We are glad to have you with us, sir.

Mr. KENNEDY. Thank you.

My name is W. P. Kennedy. I am president of the Brotherhood of Railroad Trainmen with offices in the Standard Building, 1370 Ontario Street, Cleveland 13, Ohio.

The Brotherhood of Railroad Trainmen is a recognized labor union, national in scope. It has in membership and represents railroad train service employees, such as road, passenger, freight and yard conductors and brakemen, train flagmen and train baggagemen, yardmasters, car retarder operators, and switchtenders and operators of intercity buses.

I was pleased to receive the invitation to discuss the subject of automation as it affects the transportation industry, before your honorable subcommittee. The importance of this vital subject to the members of the brotherhood impelled me to accept the invitation.

Automation, together with atomic energy, offers mankind its first real oportunity to eliminate poverty. No rational person would be opposed to scientific advances which offer such great promise for people everywhere.

No responsible trade-union representative, as far as I know, is opposed to automation as such. The fact is that our national security depends upon an increase in the rate of scientific advance in this country. While we in labor do not oppose but welcome and support policies designed to further our progress in science and invention, nonetheless we are concerned about the problems that may arise. There is little doubt that automation and other scientific inventions tend to reduce manpower requirements, and/or cause changes in the skills required of our labor force. These changes affect the stability of employment.

There is great danger in permitting a feeling of complacency to develop about the impact of automation. Because automation has been introduced in the upward phase of the business cycle, local displacement tends to be masked by the net growth in employment. But localized cases of displacement are serious. If they persist their effects will be felt nationally. If we delay in the formulation of public and private policies to deal with specific local problems arising out of the extension of automation, we run the risk that the fruits of progress may be dissipated, and may not be utilized for the lasting benefit of all our people.

I unequivocally endorse the statement made earlier this year by Senator O'Mahoney at the CIO National Conference on Automation:

> It is a production method which can exist only with mass production and mass markets. It is a problem which is beyond the political jurisdiction of local communities or even States to regulate in the public interest. If it is not regulated, it must of necessity make its own rules and those rules will be concerned with investment profit and loss rather than with the effects upon the workers and the local community.

Labor, management, and Government must work together to make certain that automation will be a stabilizing and not a disturbing element in our national economy.

RECENT TECHNOLOGICAL DEVELOPMENTS IN THE RAILROAD INDUSTRY

Technological advance on the railroads has been proceeding at a stepped-up rate since the end of World War II. Prior to automation we have had a substantial mechanization and dieselization investment program. In 1946 only 10 percent of the Nation's freight service was dieselized. Today diesels account for over 90 percent of railroad motive power. Diesels make it possible for the carriers to have longer trains and heavier loads per car. According to an ICC report,[1] the potential savings to the railroads in a single year by the displacement of steam locomotives by diesel engines was estimated at more than a billion dollars.

In addition to dieselization, the railroads have invested heavily in maintenance machinery, including robot tracklaying equipment, radio and telephonic communications equipment, centralized traffic control, automatic signaling devices, power switches, and automatic car retarders. In the 10 years since 1945 the railroads have invested over $10 billion in new plant and equipment.

The industry's investment program has been aimed at cost reduction primarily through labor displacement. Today fewer workers are needed to produce the same volume of freight and passenger revenue than were needed only a short time ago. For example, to move the 604.87 billion ton-miles in 1954 would have required 80,480 additional full-time workers on a 40-hour workweek basis in 1950.

As advances in electronics have taken place, the railroads have developed plans to incorporate them into the automatic handling and dispatching of freight cars. Railroad capital spending programs which have recently run at a rate of about $1 billion a year are expected to total $20 billion, or double the recent annual rate of investment, in the next decade. It is widely known that a great deal of this expenditure will go into automated equipment. Substantial progress has already been made in this direction.

AUTOMATION AND DISPLACEMENT

The Seaboard Air Line Railroad recently constructed a new and modern classification yard at Hamlet, N. C. This retarder yard consists of 58 classification tracks. It cost about $9 million. It was placed in operation on November 29, 1954. Immediately after the new facility was placed in operation approximately half the work force, or 74 yard conductors and switchmen, were furloughed. Subsequently 10 men were recalled, leaving 64 still displaced. It is possible for this new facility to hump more cars in an 8-hour period than was possible prior to its installation in 24 hours. Freight now classified at Savannah will in part be shifted for classification to Hamlet, which will further reduce employment for our members at Savannah, Ga.

At Hamlet the installation of the new yard has had this net result. The number of yardmen has been cut by 35 percent. The number of classifications on cars humped has been doubled. It is now possible to hump four times as many cars as before.

The Pennsylvania Railroad has just completed the new Conway yard near Pittsburgh. It is equipped with many automatic and laborsaving devices. According to a report in the Wall Street Journal, June 29, 1955, the Pennsylvania expects that this $34 million installation will ultimately pare their operating expenses by $11 million a year. Part of these savings will be reflected in reduced employment and wages.

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[1] ICC Monthly Comment on Transportation Statistics, July 18, 1950, pp. 7, 8.

Our local representative has reported that switching now done at various yards and terminals on Pennsylvania lines west will soon be classified and switched at the Conway yard. This will mean reductions in employment and payrolls at various points along the system. Communities located near the terminals where switching will be discontinued will unquestionably be adversely affected.

At the Union Railroad Co., Pittsburgh, approximately 250 yard employees have already been displaced by reason of the carrier's installation of a new automatic car retarder yard.

Out at Bensonville, Ill., where the Milwaukee put in a new automatic hump yard in June 1953, our representative reports that we have lost 13 switch crews, 4 switchtender jobs, and 7 leadmen jobs. In addition, the seniority list has been lowered from 457 men in June 1953, to 395 men on the current seniority list dated July 1955.

On the Union Pacific between Cheyenne and Laramie the road has been modernized. There were 10 telegraphers on the subdivision before the modernization, now there are none. There were 50 men on the helper board. Now there is no helper board.

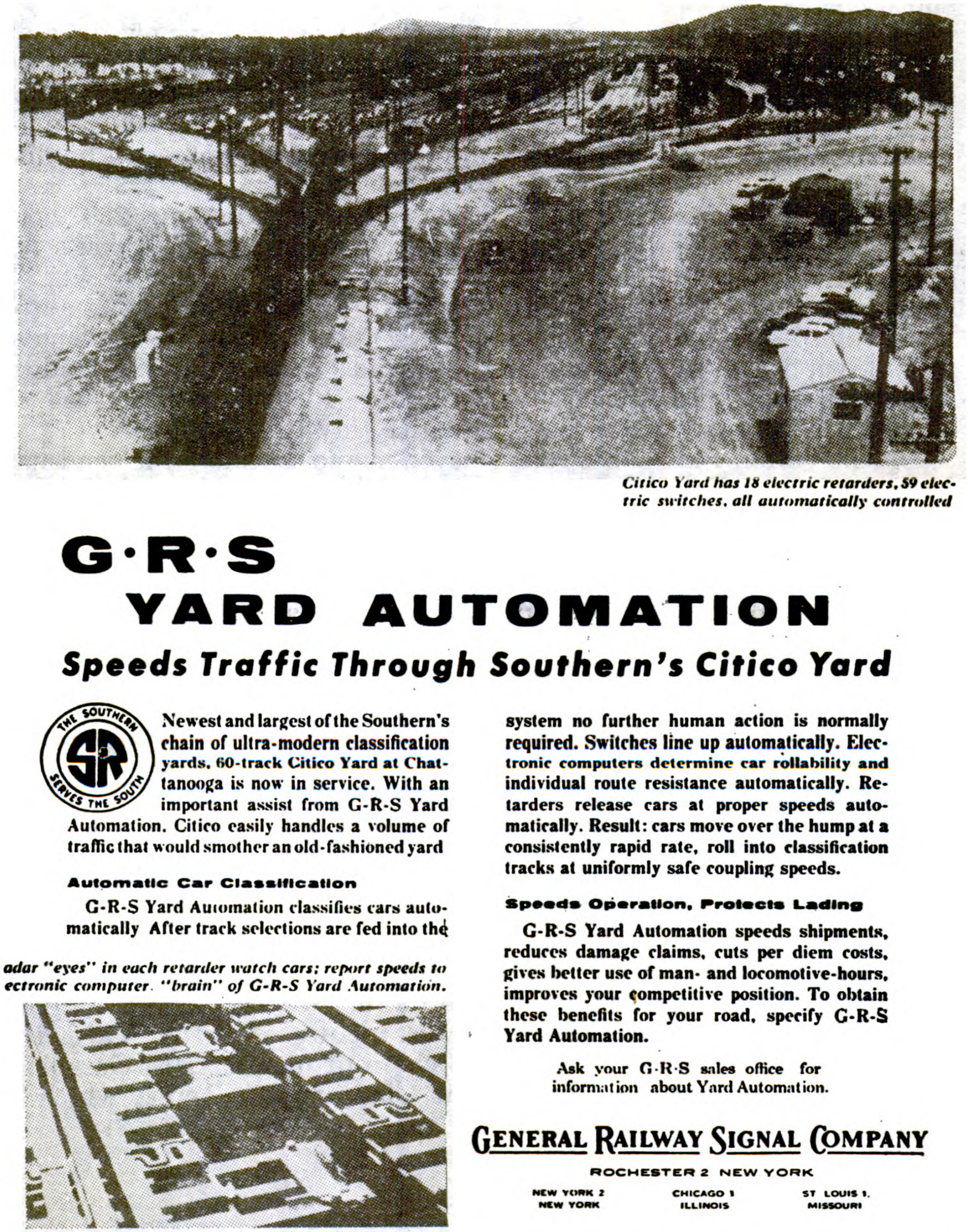
The Great Northern Railway is completing a large new classification yard at Minot, N. Dak. When this yard is finished a reduction in yard service employees at numerous yards across the system is expected.

The Northern Pacific recently installed a new automatic yard at Pasco, Wash. Fortunately, we have not had any reduction in yard forces there, or a reduction in the employment situation at nearby terminals because of the increase in business activity.

Construction of two new yards by the St. Louis and San Francisco Railway at Memphis Tenn., and Tulsa, Okla., both of which will go into service early in 1956, will in opinion of the local brotherhood representative affect the employment in the two terminals at least 25 percent.

I want to divert for a moment, to refer to an ad that appeared in Railway Age, in October 1955, placed by the General Railway Signal Co. of Rochester, N. Y. They show a picture of Citico Yard, the newest and largest of the Southern's chain of ultramodern classification yards—60-track, Citico Yard at Chattanooga, Tenn., which is now in service.

(The advertisement referred to follows:)



Citico Yard has 18 electric retarders, 59 electric switches, all automatically controlled

G·R·S YARD AUTOMATION

Speeds Traffic Through Southern's Citico Yard

THE SOUTHERN SERVES THE SOUTH

Newest and largest of the Southern's chain of ultra-modern classification yards, 60-track Citico Yard at Chattanooga is now in service. With an important assist from G-R-S Yard Automation. Citico easily handles a volume of traffic that would smother an old-fashioned yard

Automatic Car Classification

G-R-S Yard Automation classifies cars automatically After track selections are fed into the system no further human action is normally required. Switches line up automatically. Electronic computers determine car rollability and individual route resistance automatically. Retarders release cars at proper speeds automatically. Result: cars move over the hump at a consistently rapid rate, roll into classification tracks at uniformly safe coupling speeds.

adar "eyes" in each retarder watch cars; report speeds to ectronic computer. "brain" of G-R-S Yard Automation.

Speeds Operation, Protects Lading

G-R-S Yard Automation speeds shipments, reduces damage claims, cuts per diem costs, gives better use of man- and locomotive-hours, improves your competitive position. To obtain these benefits for your road, specify G-R-S Yard Automation.

Ask your G·R·S sales office for information about Yard Automation.

GENERAL RAILWAY SIGNAL COMPANY

ROCHESTER 2 NEW YORK

NEW YORK 2 NEW YORK

CHICAGO 1 ILLINOIS

ST LOUIS 1, MISSOURI

As you view this photograph, I want to call your attention that in a yard such as we are reviewing here, prior to car retarder operation, or yard automation, these cars rode down this incline into the various classification tracks with yardmen on top, and through their own power these yardmen, with brake clubs, would retard the cars as they proceeded down in the various classification tracks.

In many of these yards throughout the country, where automation, such as we view here, has taken place, it has displaced from 10 to 90 of these yardmen, and, today, one individual, a so-called retarder operator, who this brotherhood also represents, because ordinarily he is a promoted yardman, sits in a control tower at the top of the hump, and as he views the cars that are cut off to go down the incline he simply regulates the speed of these cars by touching a button on a board opposite the chair in which he sits, and so we find a very clear example of automation in its full sense now of one man displacing dozens of other employees that formerly performed work of this kind.

These are only a few examples. There are, in addition, the new robot yard being built at North Platte, Nebr., the Englewood yard at Houston, Tex., the new $15 million Southern Railway yard at Atlanta, and the Burlington's proposed electronic classification yard at Cicero, Ill.

FUTURE OF AUTOMATION

There is no question that automation will be increased in our industry. The reason why there will be a step-up in automatizing freight yards is that they pay for themselves in a relatively short period. If the Pennsylvania's estimate of its expected savings from the Conway yard is correct, then their $34 million outlay will be recovered in a little over 3 years.

Financially, the railroads are in an excellent position to carry out their proposed plan to double their rate of modernization. Net income this year is expected to exceed $1 billion, close to 50 percent higher than in 1954, and more than 10 percent above 1953. Railroad management is optimistic about 1956 earnings prospects, too.

As new developments in electronics take place they will be incorporated into the railroad's capital spending programs and labor requirements will be further reduced.

According to the Wall Street Journal of June 29, 1955:

> Electronic controls are [now] being adapted to yards to further remove manual work and individual car tending. The next step may be tape controlled yards, where even the human buttonpushing thumb won't be needed, some railroad men believe.

FACTORS AFFECTING LABOR'S ATTITUDE TOWARD AUTOMATION

Our position as regards automation is clear. We are not opposed to technological progress. The rail worker wants to see the level of rail traffic rise. He wants to see the industry prosper so that he can share in the industry's gains.

Nevertheless, there is uneasiness among our workers as they assess the advance of the new technology. Will it bring increasing unemployment rather than economic security? Will sharply rising productivity be reflected in equivalent increases in wage rates and appropriate reductions in the workweek? Or will full employment levels be undermined as growing corporate profits and dividends fail to find profitable investment outlets?

May I again call your attention to a recent newspaper report that Mr. Patrick McGinnis, president of the New Haven Railroad, will soon experiment in controlling the operation of a crewless train from a truck on a nearby highway. McGinnis has done a remarkable job in restoring sorely needed commuter service in the congested areas of New England. He deserves commendation for it. The train service employees, the engineers, the firemen, the conductors, the flagmen and brakemen all had an important part in making the restored service successful.

Really, I doubt very much that Mr. McGinnis would have been so successful in wooing the commuters back to the rails, if he had used a robot crew, directed from a vehicle along the highway. I am sure the commuters and other railroad passengers will want attentive experienced employees to be on and operate the trains they ride.

Railroad employees are also vital in the makeup of our economy.

MANAGEMENT ATTITUDES

The working man is not convinced that all in management wish to see the fruits of progress shared equitably.

They suspect there are some who view the advent of automation as a means of disciplining labor. This is not mere speculation. We have just had that type of experience on one of the railroads in the midwest.

A report I received from the chairman of a midwestern BRT lodge states:

> The management reminds me constantly of their intention of building a $2 million radar equipped hump * * * the management has been trying to threaten us for the last 5 years that they are going to build that hump and cut off 15 jobs or more.

I do not want to leave the impression that this case is typical or representative of the attitude of railroad management. It is important that the public should know there are some elements in management who would goad and provoke labor by holding automation as a club over their heads.

This is not the way to promote productivity or peaceful industrial relations.

While the majority of maangement does not resort to such crude tactics, nevertheless I was discouraged by the reports I received of the negative attitude of the carriers in connection with the installation of new methods or new automatic devices on the railroads. Our local lodge officials report that where such changes are taking place in most cases management has taken no steps to cushion the impact of displacement. They have made little effort to place the men in other jobs. They do not consult or confer with the representatives of employees when introducing automatic installations. They keep intended changes secret.

An exception has been the management of the Seaboard Air Line Railroad. The carrier did make an effort to employ the men cut off at Hamlet and at other points on the system. However, most of the work was seasonal and temporary.

It was also necessary for these employees to move from 250 to 500 miles in order to secure employment at their old occupation. Many preferred to look for other kinds of employment'

The management also did a good job in introducing this new yard to the employees. A month before the yard went into service one yard crew each day starting at the top of the seniority roster was paid to familiarize themselves with the operation of this new facility. A manual was prepared and distributed to all employees outlining the proper manner of handling cars through the yard. In addition, a booklet was prepared which contained detailed information about the operation of the new facility.

A booklet such as I hold here was distributed among the employees for their advance information as to the operation of this particular yard.

The CHAIRMAN. Would you like to have it made a part of the record?

Mr. KENNEDY. Yes; I should like to do that.

The CHAIRMAN. It may be done.

(The booklet referred to, entitled "Information and Instructions Concerning the New Freight-Car Classification Yard at Hamlet, N. C., is made a part of the record and filed with the committee.)

Mr. KENNEDY. In the interests of sound public policy, management should want to keep employees informed of its plans. They should try to work out methods of cushioning the impact of technological change so that employees will have a cooperative and constructive attitude toward the installation of the new equipment.

EMPLOYEES' ATTITUDE

Despite the negative attitude of certain carriers and the observations of our members that the result of the introduction of new automatic devices is the cutting off of employees and leaving them without work, they have cooperated with the carriers.

The attitude of our members is that as much as they dislike the prospect of automatic installations coming in and talking away jobs, they respect their contract.

We want to cooperate with management to the end that the future of our industry continues to be a bright one.

However, we believe that sound policy requires keeping the advance of automation under control, that it should not be permitted to cause sudden and substantial shifts in the stability of employment.

Gentlemen, I want to say that I don't know of any other major industry in America where the records would show that in this period of time over a million employees have disappeared from the payroll. We have just listened to an outstanding industrial representative testify, where he said that since 1938 the employees under his supervision had tripled, and, as I sat and listened to his testimony I couldn't help but bring to my mind that the industry that I am involved in, and representing the employees, has a much sadder tale to put in the record than tripling any employment, when I call to your attention, in just these short periods of years, over 1 million railroad employees have lost their positions and traveled on into economic oblivion.

Part of this was due to the inroads of competitive forms of transportation but the major factor has been the nearly threefold increase in output per man-hour in the railroad industry in the last three decades. Increased mechanization, dieselization, and automation have produced job displacement in our industry on a large scale.

The recent picture in our industry shows two disturbing facts. Between 1947 and 1954 class I railroad employment adjusted to a 40-hour weekly basis indicates a job loss of just under 500,000. Up to 1954 the major factor in job loss was the decline in traffic hauled by the carriers. However, we estimate that we have 200,000 fewer full time 40-hour jobs today due to technological factors and increased productivity. What causes us more concern is the fact that the larger

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scale investment program of the railroad industry is now beginning to show a trend toward even larger effects as far as technological job loss is concerned. Figures for the first half of 1955, while covering too short a period from which to draw any fixed conclusions, do show a trend toward a stepped-up rate of technological displacement through increased productivity. In other words, there seems to be evidence of a substantial upsurge in output per man-hour in our industry during the first half of 1955.

In the yard and switching service we had 3,468 fewer conductors, brakemen, helpers, and switchtenders employed in June of this year than we had in June 1953.

These job losses reflect a decline of over 4 percent in employment in the yard and switching service in the last few years even before the introduction of the new automatic yards.

We have recently concluded a successful wage movement with the carriers which provided for wage gains for both our road and yard members. However, the decline in jobs may require railroad labor organizations to give serious consideration to a reduction in the workweek as the only plausible answer to increasing automation of railroad transportation.

SAFETY ASPECTS OF AUTOMATION

I would like to say a few words about the safety aspect of the new automatic devices. The railroad employee has good reason to welcome any development that will make railroading a safer occupation. Our brotherhood has throughout the years worked unceasingly to secure the passage of laws and the promulgation of orders by the Interstate Commerce Commission to protect the safety of railroad employees. All too often the carriers have fought our efforts. Now we hear the carriers are stressing the safety aspect of automation. As far as safety is concerned, yard employees do not feel that the automatic yards are foolproof. In some cases our members have found that the installation of automatic retarder towers have made certain jobs more hazardous and increased the amount of merchandise damage in freight cars.

In other instances, however, we have heard that the new automatic hump has improved safety conditions. In all too many instances we still find that BRT efforts to increase safety on the property, by citing safety violations and urging the correction of unsafe conditions, are not welcomed by certain carriers. Management preaches but does not practice safety particularly where it may involve monetary outlays without any immediate prospect of financial savings. We have on record many cases where the carrier has refused to correct unsafe conditions which are in violation of ICC orders.

Unfortunately, the attitude of the carriers in the past with respect to safety conditions and the maintenance of past attitudes by certain carriers today leads our employees to conclude that safety of operation is a secondary consideration. Expediting movement through the installation of automatic devices is the paramount consideration of many carriers. Too often the question of how many cars can be put over the hump in a designated time period comes before the safety of employees.

We are going to continue our efforts to see that the safety and welfare of our members is not jeopardized by the arbitrary decisions of certain carriers.

AUTOMATION AND PRODUCTIVITY

Like any other technological innovation automation results in increased productivity. Increasing productivity, however, means that fewer workers are needed to produce a fixed volume of goods and services or that the same number of workers can produce more for each hour they are employed.

While productivity is a worthwhile objective, it does not automatically create prosperity. Productivity leads to material progress and higher living standards only as long as our economy continues to expand fast enough to maintain full employment.

Productivity increase makes it essential for total business activity to continually expand or else unemployment will grow. If business is to continue to expand at an appropriate rate we must make sure that there is enough purchasing power to warrant business expansion. If demand does not keep pace with growing productivity then goods will pile up unsold on the shelves of merchants, production will be interrupted and unemployment will increase.

In the last 2 years productivity in manufacturing industries has apparently been rising at a rate in excess of the postwar average of 4 percent per annum. According to some estimates productivity jumped about 6 percent in the last year.

As automation is developed on a larger scale productivity increases can be expected to grow. It is therefore more important than in the past that public and private policies be geared toward expanding consumer demand fast enough to keep pace with rising productivity and hold unemployment at minimum levels.

Part of the benefits of increased productivity should, of course, be reflected in a shorter workweek. In this connection we in the railroad industry have lagged behind the rest of the economy in enjoying some of the leisure that increased productivity makes possible.

Cost savings resulting from the application of new methods and techniques should be appropriately reflected in the division of our total national income. If purchasing power is not sufficiently expanded, then we shall certainly witness the persistence of local pools of unemployment even at relatively high levels of business activity.

Take 1955 as a case in point. Consumer expenditures have risen substantially reflecting increased wages and employment, some tax reduction and a rather sharp rise in the use of installment credit. But even this rather large expansion in consumer demand has not been sufficient to overcome the employment displacing effects of automation and other technological advances contributing to a sharp increase in productivity. We have not yet been able to reduce the unemployment rate to the 2 to 2.5 percent full employment level. 1953 was a "full" employment year. In that year unemployment as a percent of a smaller labor force than we have today averaged 2.5 percent. In the first half of this year unemployment as a percent of the civilian labor force has averaged about 4.5 percent. This summer in the midst of a so-called inflationary boom unemployment averaged 3.5 percent of the labor force. In June 1953 the unemployment rate was 2.4 percent.

Unemployment today is 800,000 above the low level reached in the summer of 1953. These are the official census figures of full time unemployment based upon active labor force participation. They do not reflect the extent of disguised unemployment that may exist, because of older workers removing themselves from the labor force. Census data show that older age groups have not shown as large an increase in labor force participation this year as we might expect under conditions of expanding business activity.

In manufacturing industries we are producing more than we did 2 years ago while employing 800,000 fewer production workers. Hours of employment are about the same as they were in 1953.

In our industry the ICC reported that employment during the first half of 1955 averaged about 13 percent below the 1953 monthly average whereas the ton-miles of revenue traffic performed were only 3 percent below 1953 on a monthly average basis.

In addition to replacing the jobs lost as a result of technological advance the number of jobs necessary for full employment must be large enough to take care of additions to our labor force. Recently this number has been about 750,000 a year. However in the coming decade when we expect automation to be installed at an increased pace and thereby to raise the number of jobs that will have to be replaced, Census Bureau estimates indicate the working age population will begin to reflect the sharp increase in the birth rate of the 1940's. In the 5 years 1960–65, according to census estimates, the annual increase in the population of working age is expected to average about 1.2 million. (Source: Current Population Reports, Series p. 50, No. 42.)

Changing tastes, and the development of new products and services may serve to offset the job loss suffered because of declines in some industries. But the presence of a relatively large number of distressed textile, coal, and railroad centers testifies to the fact that output and demand are not expanding rapidly enough to prevent permanent pools of unemployment from developing.

These pools of unemployment threaten to increase. In our industry we are faced with the prospect of workers becoming isolated in communities where switching and terminal facilities are to be closed down as the new large push-button yards are placed in operation. As automation proceeds we may find more and more people becoming stranded in towns, industries, and occupations where employment opportunities are on the decline. This is why we must face up to the necessity for a sharply increased rate of economic expansion than we have experienced in the past. This is why we must turn our attention to the urgent problems of retraining, of relocating and providing financial assistance to those who have already fallen victims and to those who may become victims of the technological displacement decade.

RECOMMENDATIONS AND PROGRAMS

As far as a program and recommendations are concerned, I should like to mention briefly one problem that we find in our industry. Too often we are told that the answer to technological displacement is labor mobility or the exercise of a little individual initiative. We would suggest that the virtue of labor mobility is something that should be thought through carefully by those who would place greatest emphasis on that aspect. In our industry we have had an aging of our work force.

According to the Railroad Retirement Board, about 5 percent of those who worked in railroad occupations in 1953 could be classified as aged workers. Our increase in the proportion of aged workers to the total labor force has been somewhat greater than the rest of the labor force, although this trend is evident in the total labor force also.

It is not easy for an older couple with children, maybe grandchildren, a home, friends, and roots in the community to pick themselves up and go hunt for a job across the country. Similarly it is not easy for them to acquire new skills, if the skills are made obsolete by the advent of automation. Special attention needs to be given to the special problems of the older workers.

In any event, there is no reason why the worker should have to bear the full brunt of technological change. Some provision for liberalizing the retirement age and/or severance pay allowances should be developed to mitigate the impact of displacement in the older worker category.

For the younger more aggressive workers mobility may be a lot easier. But here again there is no reason why automation should not be made to pay its own way. Many younger workers do not have the finances to acquire the skills that automation will require. They should be assisted during a period of retraining. In addition, some help may be needed to relocate them if they are caught in one of the stranded communities.

For instance, why should a railroad which needs additional employees to carry on its business in one location hire new employees when employees of the same class or craft are without work due to automation or a reduction in business on other terminals or divisions of the same railroad? Another further example, why should a railroad enjoying peak business employ new workers when other railroads in that same territory have surplus employees in the same craft or class due to lack of business or automation?

We have in this country a great many railroads of more than a thousand miles in length. Some of them operate from Chicago to the west coast. Railroads operate, for instance, from the Portland, Oreg., area all the way to El Paso, Tex. We have railroads here that operate from St. Louis, Mo., to New York City, and strange as it may seem, on many of these railroads, and I will say a large majority of the railroads, if it is necessary, because of business activity in an industrial center, such as St. Louis, Mo., to hire new employees, they automatically hire those new men from outside of the railroad labor force, many of them have had no experience whatever in the railroad industry, and notwithstanding the fact on that same railroad maybe 500, 700, or 1,000 miles away they may have a surplus number of employees in that same craft or class, who know nothing about these openings and who are given no opportunity whatever to even decide or select the opportunity of traveling on that same railroad and go and pick up the new job, which many of them would be only too pleased to perform.

Now, the other example is this: Some railroads are a little more prosperous than other railroads. Up until this moment, a prosperous railroad that needs new employees wouldn't carry on a conversation with an adjacent railroad in the same city and in the same territory, that has a surplus number of employees, for the purpose of ascertaining whether or not they would permit those surplus employees to come over to the property that is enjoying this business activity, temporarily or permanent, and enjoy work in their own category and in their own industry. They don't do that.

The CHAIRMAN. Can't the ICC do something about that?

Mr. KENNEDY. I presume they could if it is officially called to their attention.

The CHAIRMAN. That seems to be a terrible thing to me. It is inexcusable.

Mr. KENNEDY. Well, it is, and I am trying to forcibly bring this to the attention of the railroads. As a matter of fact, all of the railroad labor executives recently called this important subject matter to the attention of a number of presidents of railroads for their information.

Now, as I point out here, we are an industry that is shrinking by the thousands, and strange as it may seem, they are hiring men today on railroads in certain parts of the country, while in other sections of the country we have men from 10 to 15 years' seniority walking the streets and unemployed.

The CHAIRMAN. Are they hiring inexperienced men?

Mr. KENNEDY. Inexperienced men?

The CHAIRMAN. Yes.

Mr. KENNEDY. Yes, sir; they are.

One of the factors that I want to point out to you is this: Certain railroads have an age limit and they won't hire an individual if he is beyond an age limit.

The CHAIRMAN. What is the age limit usually?

Mr. KENNEDY. I would say for a new employee in train and yard service it is approximately 25 years of age, and so if an experienced man may be available, and he would happen to be 40 years of age, and of those 40 years he may have been on a railroad for 20 years, they would not hire him because it would be contrary to the policy of that particular railroad.

The CHAIRMAN. I am impressed that that is a major problem that should receive attention until it is worked out satisfactorily.

Mr. KENNEDY. With the introduction of automatic machinery on a large scale the problem of production will be relatively minor. We will on the other hand be confronted with an opportunity to enjoy more leisure time. This should give stimulus to the attainment of the 3-day weekend. Reduction in the length of the workweek accompanied by appropriate wage adjustments to safeguard purchasing power will give us all an opportunity to enjoy increased recreational and cultural activities. We in the railroad industry feel that a part of the brighter future of the railroads may in part depend on how the industry exploits the prospects for greater travel by our citizens.

Of course, we expect to take increased productivity into account in our collective bargaining with the carriers on matters of wages, vacations, means of stabilizing employment on a year-round basis, and provision of more adequate medical care for railroad employees and their families.

Automation is both a challenge and a promise. Its fruits will not be realized if we adopt an attitude of complacency and inertia.

One of the most serious aspects of the automation challenge lies in the field of education. We are not now turning out enough technicians and professional graduates in engineering, physics, mathematics, and electronics to be certain that we can keep on making the advances in automation we are now anticipating. We are at present even faced by the prospect of a deficit in the number of skilled personnel who will be needed to run and maintain the automated machines and systems.

Clearly this is an area—the field of education—where the Federal Government has a great responsibility. The lag in training scientific personnel is dangerous not only because of its implications as far as automation is concerned, but also because we are losing our superiority in this field so essential to national defense. A well-rounded Federal aid to education program ought to be No. 1 on the calendar of the coming session of Congress.

I believe that our economy can make the transition to automation without any severe unstabilizing effects if Government, industry, and labor will act wisely. This assumes that we shall act with the precision and with the spirit that is implicit in the Employment Act of 1946.

In our industry I want to pledge the carriers our wholehearted cooperation to improve the outlook for the railroads and to carry the industry to higher and higher levels of rail traffic. I believe that the industry is in the most splended financial and technological position it has ever been in and from that position can aggressively meet the challenge of competitive forms of transportation.

An important development helping to make up that bright future is the so-called piggyback movement of freight traffic, which we in the B. of R. T. are proud of having promoted from its very inception. We shall continue our efforts to help build up our industry to the prominent position it so long enjoyed in carrying the Nation's passengers and its freight. We ask only that the carriers recognize that there is a mutuality of interest on our side as well as theirs in maintaining good relations and in promoting the health and expansion of the industry. We ask that the carriers recognize that while a divergence of economic interests exists between us over issues of wages, working conditions and jobs, there is no reason why these cannot be adjusted best in the interests of both parties and the economy through honest collective bargaining.

Great technological change has been occurring in the railroad industry over the past 35 years. During that period railroad labor has struggled to win some protection for its members against the unilateral decisions, the arbitrary and uncontrolled discretion of certain carriers to eliminate jobs. Out of the needs and demands of our members confronted with technological change and declining job opportunities we have developed a set of work rules that work well for the most part. Our aim has been to protect our members from bearing all the cost and the impact of technological change.

We have won considerable protection for our members which has enabled them to share in the fruits of progress. At the same time, our efforts have not retarded, but aided, the growth of efficiency in the railroad industry. The record of productivity increase in our industry speaks for itself. Deaths and accidents in railroad travel are a rarity. A person is safer in a pullman than in the average bathroom of his own home. Railroad employees have built up record as one of the safest groups of employees in any industry. Nor have our efforts handicapped the railroad industry in raising capital for replacement and investment in new equipment. On the contrary, labor statesmanship has helped to make the railroads a recognized safe investment with a promising future.

I have cited these facts to impress upon the members of this subcommittee, and the public, that although the introduction of technological advances in the past has been subject to certain rules and regulations worked out in collective bargaining between the railroad labor organizations and the carriers, it has not been a bar to progress or to the investment of new capital in the railroad industry.

We in the labor unions of the transportation industry welcome the application of science to our problems, for in so doing lies the great hope of lifting burdensome labor off our backs and of providing that level of good living which a full employment economy should make possible.

Finally, let me give you some comparison figures to show what has taken place in the railroad world in just past 24 years. Miles of track operated back 25 years ago was 426,553. Miles of track operated in 1954, 393,000, a total shrinkage in miles of track operated, 33,553. In other words, taking 3,000 miles between this city and the west coast, these figures represent a shrinkage in railroad trackage in that period of time of 11 pieces of track, 3,000 miles long, between here and the coast.

Let's take a look at the locomotives in service, 1926–30, average, 39,553. Today, 1954, 32,761; 26,792 fewer locomotives in service than there were 25 years ago.

Take freight cars in service: Formerly there were 2,305,087 freight cars. In 1954, 1,735,900. In 25 years, the freight cars in service have shrunk 569,187; and today, gentlemen, thousands of thousands of carloads of lumber and other material are piled up on the west coast of this country, in Oregon, in Washington, and in California, for shipment to the eastern and central parts of this country, and there isn't an available boxcar nor a flat car nor a gondola to use to ship that commodity, lumber, or whatever it is, to this section of the country.

Somebody must have lost the ball somewhere during the last 25 years. As I read in the paper this morning, the Pullman Co. that manufactures cars is laying off a large number of their employees in their shops because they haven't got the material to build the cars that the railroads now want to use.

The CHAIRMAN. And a lot of that material is on the west coast?

Mr. KENNEDY. Just piled up there.

The CHAIRMAN. And cannot be shipped because of the lack of cars?

Mr. KENNEDY. That is right. Not only that, but strange as it also may seem, the railroads on the west coast apparently have a surplus number of cars that could be used to haul this lumber, but those cars happen to have been previously loaded and are now circulating in the eastern section of this country, and under the rules and regulations of the railroads themselves, an eastern railroad can keep that western carrier car on its property by paying a per diem rental for operation, instead of sending it back empty to the west coast to come back again east with a load of lumber.

Let's look at the tons. Average freight-car capacity, 25 years ago, was 45.9 tons. Today that has increased to 53.8, or 7.9 tons increase. In other words, they are building bigger cars today than ever before.

Average freight trainload, 25 years ago, the average load was 786 tons. Today, the average load is 1,287 tons, an increase of 501 tons.

The CHAIRMAN. How many carloads would that be? How many cars to the train would that be?

Mr. KENNEDY. That is the next figure.

The CHAIRMAN. 65 cars average?

Mr. KENNEDY. Yes.

Now did I give you the total capacity of freight cars?

The CHAIRMAN. We have it here. Supposing we put this in the record.

Mr. KENNEDY. All right.

(The information above referred to is as follows:)

The railroad industry today compared with 25 years ago

	1954	1926–30 average	Difference
Miles of track operated (p. 6)	393, 000	426, 553	−33, 553
Locomotives in service (p. 8)	32, 761	59, 553	−26, 792
Freight cars in service (p. 11)	1, 735, 900	2, 305, 087	−569, 187
Average freight-car capacity (p. 12)........tons	53. 8	45. 9	+7. 9
Total capacity of freight cars (p. 13)........do	93, 410, 000	105, 742, 114	−12, 332, 114
Average freight trainload (p. 43)........do	1, 287	786	+501
Cars per average freight train (p. 44)	65	46. 4	+18. 6
Average freight train speed (p. 45)..miles per hour	18. 7	12. 8	+5. 7
Passenger train cars (p. 15)	32, 800	53, 216	−20, 416
Number of employees in service (p. 81)	1, 064, 705	1, 663, 896	−599, 191
Revenue ton-miles (p. 30)	549, 240, 663, 000	427, 233, 957, 000	+122, 016, 706, 000
Operating revenues (p. 58)	\$9, 370, 905, 784	\$6, 038, 338, 548	[1] +\$3, 332, 567, 236

[1] Better than 50 percent.

Source: Yearbook of Railroad Information for 1955, issued by Eastern Railroad President's Conference, 143 Liberty Street, New York, N. Y. Submitted by W. P. Kennedy, president, Brotherhood of Railroad Trainmen in testimony before the Congressional Joint Committee on the Economic Report, Oct. 26, 1955.

Mr. KENNEDY. Let's go to the cars per average freight train. Twenty-five years ago it was 46.4. Now it is 65 cars, an increase of 18.6 cars.

Average freight-train speed, 25 years ago, was 12.8 miles per hour. Today that average speed is 18.7 per hour, an increase of 5.9 miles per hour.

Passenger-train cars, 25 years ago, 53,216. Today, 32,800, or 20,416 less passenger cars.

Number of employees in service, 25 years ago, 1,663,896. In 1954, 1,064,705—599,191 fewer employees. In 25 years we have lost just approximately 600,000 employees, and as I previously told you, if you wanted to go back 30 years, you would find that that figure would jump to approximately a million.

Revenue ton-miles increased from 427 billion some odd millions to 549 billion, or an increase of 122 billion revenue ton-miles.

Operating revenues, 25 years ago, was \$6,038,338,548; 1954, \$9,370,905,784, or an increase in operating revenues of \$3,332,567,236, or better than 50 percent.

Gentlemen, I want to thank you for the opportunity of giving you this information and giving you these facts and figures, for whatever benefit your committee may so choose to use.

The CHAIRMAN. We want to thank you, Mr. Kennedy. The information you have given us will be of great benefit to us in this study.

I notice one thing about this table, which we will put in the record, that rather stands out in my mind: The number of employees over this 25-year period. There were 60 percent more employees 25 years ago than now. The ton-miles have increased greatly, the revenue ton-miles, and more significant than anything else, the operating revenues have increased from $6 billion to $9 billion a year, or an increase of 50 percent.

That is rather interesting.

I had a lot of questions, Mr. Kennedy that I expected to ask you, but I listened carefully to the reading of your statement and I think you have covered all of them. I think you have answered them all.

Mr. KENNEDY. I want to point out, Mr. Chairman, one thing: I have given you a lot of figures, but I was very careful to also give you the source from where these figures originated, because they originated from the railroads themselves, in their own yearbook, of which they publish each year, of which they furnish me, and anybody else that is interested in the railroad industry, a copy, and each one of these things, regardless of what they disclose, can be found in the yearbook of the Association of American Railroads by the Eastern Presidents Conference Committee.

The CHAIRMAN. You give the source of it here in your statement.

Mr. KENNEDY. That is right, so there will be no controversy between the railroads and myself as to whether or not these figures are authentic, because if they are not authentic, then the railroads have failed to give the truth in their book.

The CHAIRMAN. In view of the lateness of the hour, we will not ask you any questions now, Mr. Kennedy, but we will reserve the privilege of submitting any questions in writing we desire to get answers to.

Mr. KENNEDY. All right.

The CHAIRMAN. That will be before the hearings are closed.

We want to thank you again very much for your testimony.

Senator O'MAHONEY. As a member of this subcommittee, I hope that the busy Members of Congress in both Houses will make an opportunity to follow these important hearings on what automation portends for our economy and for the people who are affected by the installation of these remarkable new inventions. Congress cannot perform its constitutional function "to regulate commerce" unless it keeps pace with the amazing technological progress of our times.

In my own State of Wyoming, where distances are great, the railroads despite the expansion of air and bus traffic, provide now, as they did in the pioneering stage of development, the principal form of freight transportation. Their labor force constitutes one of our most important groups of citizens. Consequently, what happens to the railroads and their employees has a direct bearing on the welfare and future of our whole State.

I am therefore deeply interested in the testimony of my good friend, the able and farsighted president of the Brotherhood of Railroad Trainmen, Mr. W. P. Kennedy, who has been presented before this committee. I know that because of his long experience in active railroading; because of his widespread network of local lodges and representation of rail workers across the entire Nation; because of his participation and leadership in national and international organizations seeking the solution of our social and economic problems, Mr. Kennedy is well fitted to present the facts, and with his fine mind and equally fine spirit draws conclusions which are worthy of the attention not only of all those engaged in the railroad industry, but all those who wish to preserve a really fine economy beneficial to all the people.

I wish to assure him, and all workers in transportation, that his testimony will receive from me the closest attention and his recommendations will be accorded the utmost favorable consideration.

Mr. KENNEDY. Thank you, Mr. Chairman, and the subcommittee.

(The information above referred to is as follows:)

(The following material was submitted for the record in accordance with the chairman's request as additions to the statement and testimony submitted by W. P. Kennedy. It is based on a study made by the Public Affairs Institute, of Washington, D. C.:)

CHART ON RAILROAD WORK LOSSES

(1) This chart is based on all employment on class 1 roads as reported by the Bureau of Labor Statistics. It includes all officeworkers and salaried people as well as active railroaders.

(2) The chart shows employment on a 40-hour basis for each year. This is the only way in which the years can be compared. The hours of the production workers are taken as the hours for all workers. The following table shows the conversion from actual employment to the 40-hour basis. The figures in column 5 are the ones shown in the chart.

TABLE 1

	Actual employment (1)	Hours per week (production workers) (2)	Hours per year (3)	Total hours worked by labor force during year (4)	Employment in 40-hour base (column 4+ 2,080 hours) (5)
				Thousands	
1947	1,352,000	46.4	2,412.8	3,262,105	1,568,310
1948	1,327,000	46.2	2.402.4	3,187,985	1,532,680
1949	1,191,000	43.7	2,272.4	2,706,428	1,301,160
1950	1,221.000	40.8	2,121.6	2,590,474	1,245.420
1951	1,276.000	41.0	2,132.0	2,720,432	1,307,900
1952	1,226.000	40.6	2,111.2	2,588,331	1,244,380
1953	1,207,000	40.6	2.111.2	2,548,218	1,225.100
1954	1,064.000	40.7	2,116.4	2,251,850	1,082,620
Preliminary 1955	1,020.000	41.4	2,152.8	2,195,856	1,055.700
Decrease, 1947-55	−332,000				−512,610

Table 1 (col. 1) shows that there may be a drop in actual employment of 332,000 between 1947 and preliminary 1955. This would be 24.5 percent—almost one-quarter of the 1947 employment. However, as column 5 indicates, on a constant 40-hour base the real drop in available 40-hour work may be 512,610 or 32.7 percent of the 1947 labor force, almost one-third in 8 years. The decline in working hours per week accounts for much of the difference.

(3) Production per man-hour increased by about 18 percent from 1947 to 1954 and may be as much as 31 percent over 1947 to 1955. This is shown in column 4 of table 2. Total man-hours worked decreased by 31 percent in 1954 (column 5).

The index of production was obtained by adding together (revenue freight ton-miles) plus (revenue passenger miles multiplied by 1.9). The combined revenue miles are given in column 1. In column 2 they are put into an index with 1947 equals 100. This index divided by the total hours worked (table 1, col. 4) indicates the production per man-hour in column 3.

TABLE 2

	Output in mixed revenue ton-miles (millions) (1)	Index of output (1947=100) (2)	Production per man-hour (mixed ton-miles) (3)	Index of production per man-hour (1947=100) (4)	Index of total hours worked (1947=100) (5)
1947	741, 976	100	2. 27453	100	100
1948	716, 157	96. 52	2. 24642	98. 76	97. 72
1949	593, 781	79. 95	2. 19174	96. 36	82. 96
1950	648, 922	87. 46	2. 50503	110. 13	79. 41
1951	712, 687	96. 05	2, 61975	115. 18	83. 39
1952	679, 371	91. 56	2. 62474	115. 40	79. 34
1953	666, 030	89. 76	2. 61370	114. 91	78. 11
1954	604, 870	81. 52	2, 68610	118. 09	69. 03
Preliminary 1955	655, 558	88. 35	2. 98543	131. 25	67. 31

(4) That part of the loss of employment which was due to lower output (less freight and passenger movement) is derived from column 2 of table 2. In 1948, it was 3.48 percent lower than in 1947; in 1949, it was 20.05 percent lower. In 1954, it was 18.48 percent lower. When those percentages are applied to the hours worked in 1947 (3,262,105,000) the amount of dis-employment since 1947 due to loss of business is accounted for. Table 3 shows this amount in column 3 and the residual amount, which is due to increased productivity because of technological changes in column 5 in employment lost.

TABLE 3

	Cumulative drop in hours worked from 1947	Drop in hours from 1947 due to decreased business		Work change from 1947 due to decreased business (col. 3÷2,080)	Work change due to technological change	Total cumulative work loss (40-hour basis)
		Percent	Hours			
	(1)	(2)	(3)	(4)	(5)	(6)
	In thousands		*In thousands*	*Workers*	*Workers*	*Workers*
1948	74, 120	3. 48	113, 521	−54, 577	+18, 943	−35, 634
1949	555, 677	20. 05	654, 052	−314, 448	+47, 345	−267, 103
1950	671, 631	12. 54	409, 068	−196, 667	−126, 184	−322, 851
1951	541, 673	3. 95	128, 853	−61, 948	−198, 471	−260, 419
1952	673, 774	8. 44	275, 321	−132, 365	−191, 563	−323, 998
1953	713, 887	10. 24	334, 039	−160, 595	−182, 619	−343, 214
1954	1, 010, 255	18. 48	602, 837	−289, 825	−195, 874	−485, 695
1955 (preliminary)	1, 066, 249	11. 65	380, 035	−182, 709	−329, 901	−512, 610

It will be seen in column 4 of table 2 that there was a decline in productivity in 1948 and 1949 for all railroad workers combined, with the result that the loss of employment opportunity in these 2 years because of business conditions, shown in table 3, was slightly offset (col. 5 of table 3).

Column 1 of table 3 shows the cumulative decline in hours worked since 1947. Column 2 shows the percentage decline in load carried since 1947. That percentage is aplied to the total hours worked in 1947 (3,262,105,000) to obtain the hours lost since 1947 because of a loss of business. These hours are converted in column 4 into work lost at 40 hours per week or 2,080 hours annually. Column 4 shows the work decline due to loss of business by years since 1947. The remaining work loss is due to increased productivity and is shown in column 5. The total work loss (in 40-hour-week employment) is shown in colunm 6. It is the sum of columns 4 and 5.

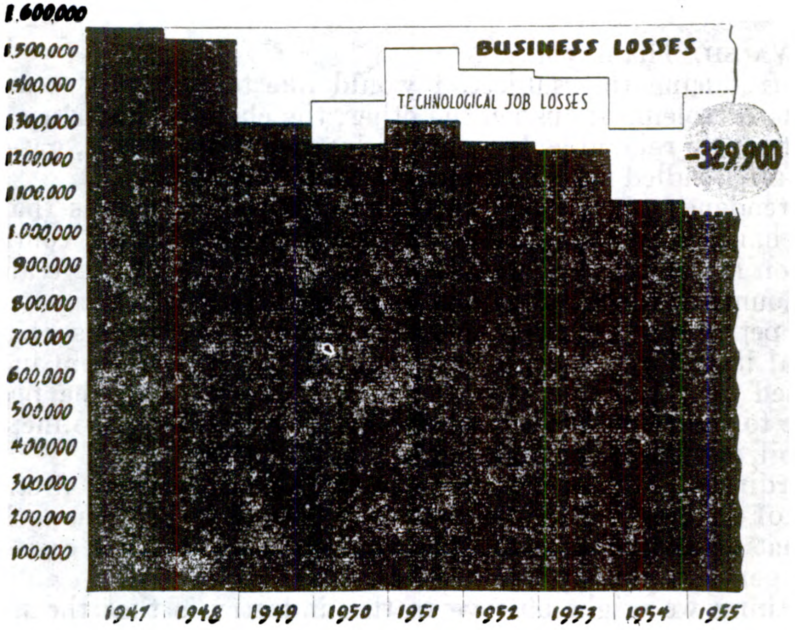
These figures indicate that by 1954 there was roughly a work loss of 485,700 since 1947, of which 195,875 were due to improved technology or productivity. This is about 40 percent of the total for 1954. However, in 1951, 1952, 1953, and apparently in 1955 the technological work loss was larger than the work loss due to business conditions. In 1955 it may possibly reach 329,900.

The 1955 figures are throughout to be taken as very preliminary since they are based only on the first 5 months of 1955.

The real extent of technological displacement is very conservatively stated in this chart and those tables, because office and supervisory employees are included. These were only 18 percent of the total in 1947 and are now 21 percent.

On the question of hours of service and the conversion of lost overtime to full-time equivalent employees—40-hour basis—the reduction in hours from December 1947 to December 1954 has been checked. The bulk of it is a reduction in straight time hours worked. This reflects the actual decline in employment. There is however a decline in service hours between December 1947 and December 1954 attributable to a reduction in overtime and other allowances which roughly equals about one-fifth (21.3 percent) of the total decline in stright-time hours worked (Public Affairs Institute, October 1955).

ESTIMATE OF
RAILROAD JOB LOSSES
1947 - 1955
ALL EMPLOYEES - 40 HR. WK. BASE
CLASS I RR



The CHAIRMAN. Without objection, the subcommittee will stand in recess until 2 o'clock here in this room.

(Whereupon, at 12:18 p. m., a recess was taken to 2 p. m.)

AFTERNOON SESSION

The CHAIRMAN. The subcommittee will please come to order.

We have with us today Mr. Thomas J. Walsh.

Professor Walsh, we are looking to you to add to our understanding of the influence of automation upon developments in the chemical industry. Last week Mr. Pragan, of the International Chemical Workers Union, told us that the number of production workers in the chemical industry has increased very little in recent years in spite of the great increase in production.

This industry, as we know, is a very highly automated one, and has more or less grown up that way. I hope that you can help us to understand the factors which have made this so. Is it essentially because it is a continuous-flow industry; is it because it is a 24-hour-a-day, 7-day-a-week industry; or is it that some of the products are of the character with which human contact must be avoided? I hope, too, that your testimony will give us a little insight into what I take to be a closely associated industry; that is, petroleum refining and petroleum chemicals.

I notice, too, that you are the chemical group director, automation project, at Case Institute. Perhaps you can tell us a little bit about the origins and significance of your having an automation project at the institute.

Dr. Walsh, we shall be very glad to hear from you. You may proceed in your own way.

STATEMENT OF THOMAS J. WALSH, CHEMICAL GROUP DIRECTOR, AUTOMATION PROJECT; PROFESSOR, CHEMICAL ENGINEERING, CASE INSTITUTE OF TECHNOLOGY, CLEVELAND, OHIO

Dr. Walsh. Thank you.

In introducing this subject, I would like to talk to two aspects: One, the petroleum industry, the other, the chemical industry.

The two are related as both are industries where fluids, gases, and liquids are handled more characteristically than solids.

The tendency of material such as fluids to flow means that they can be handled in pipes in a continuous process. This continuous operation is the chemical plant equivalent of what I believe automation amounts to in the mechanical-process industry.

The petroleum industry is much more homogeneous than the chemical industry. I mean, the products in the petroleum industry are based on a common raw material, crude oil, and the products for sale to the consumer are a common type, mainly, gasoline, lubricating oil, and the other materials of similar nature.

Accordingly, we can consider the petroleum industry first. The degree of automation in the petroleum industry is perhaps higher than that of any other industry, so if we use that as a case study, we can, perhaps, pick up a few trends.

One thing we might observe in this industry is that the production is independent of the number of workers in a plant. With automatic controls it is just about as easy to operate a cracker handling 20,000 barrels per day of oil as it is a cracker handling 5,000 barrels a day of oil. In fact, it is easier than to handle one handling 500 barrels per day of oil.

With this start, we might note that the average size of petroleum refineries has been increasing for several years. At the same time, the number of petroleum refineries in the United States is decreasing.

I have included in my prepared statement a short table, showing that since 1951 the number of refineries in the United States has decreased from 325 to 308; at the same time the average capacity has increased from 20,000 barrels a day to 25,000 barrels a day.

I might add that the largest number of refineries we had in the country, about 1946, was over 410. The average-sized refinery at that time was about 8,000 barrels.

During 1954, 7 refineries were under construction, with an average designed capacity of 58,000 barrels a day. Nonoperating refineries were 29, and they had an average capacity of 7,750 barrels.

By this I hope to show that the trend is toward larger refineries, with a smaller number of refineries in the country.

You might also observe that the national capacity for re-refining crude oil is increasing yearly. However, a refinery is not a manless plant. Some people think automation means plants with no men. The industry has found that this type of plant is not practicable. Perhaps the reason for this is that they wish to have on hand a certain group of men for routine duties and emergencies, so they are operating in what the trade calls an open loop process. Perhaps I should define the term.

We talk about a flow controller in a simple flow line. We put an orifice in the line, the pressure drop measured across the orifice is a function of the quantity of material flowing. This pressure drop can be used through relays and controllers to activate the valve which will increase or decrease the resistance of the line, so that a preset quantity of material will be caused to flow. This is a closed loop.

Now, if a man reads the barometer connected with the orifice, decides what the pressure drop means and then personally activates the valve either through a motor or by hand, this is open loop. The man is closing the loop. The refinery has found that they wish to operate in open loop behavior.

This does not preclude the possibility of having a common control room for an entire process. All the instruments can be connected, pneumatically or electrically, to the common control room, and one senior operator from this control room can determine what changes he wants to make in the process for optimum operation.

The assistant operators are located around the plant, and can be instructed by loudspeakers or by telephone.

The number of refinery employees in the country showed a dip a few years ago and then increased to new peaks. The total number of workers in industry has risen almost steadily. There was the small break one year and then an increase after that.

However, within the refinery the ratio of hourly workers to salary workers has decreased. You might also observe in table 2 that the number of nonsalaried workers is not as great today as it was in 1948, while the number of salaried workers has increased appreciably.

You will also notice that the ratio in the table of nonsalaried to salaried workers decreased from approximately 3 in 1947–48 to about 2¼ in 1953. This seems to indicate a trend.

The industry is employing more people on salary, fewer people at hourly rates. The people on salary are generally expected to have higher skills and to have more responsible control of the operation.

The CHAIRMAN. They are the ones that you would call the engineers and technicians, the salaried people?

Dr. WALSH. Pretty much, although there are also salaried people who will be serving as operators, foremen, things of that nature—supervisory posts in general would be salaried.

We might also observe in this same table that the percent of total industrial workers has decreased since 1947–48; that is, the refineries are currently hiring about 13.4 percent of industries total workers,

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salaried and nonsalaried, whereas in 1947 or 1948 they hired about 15.7 percent of the total industrial workers.

Another way of considering this table with table 1 would be that there are approximately 700 workers per refinery.

The CHAIRMAN. May I ask you this question: There was a considerable drop, according to your figures, in table 2, 1949 to 1950. The percentage of refinery workers was 15.3 in 1949, whereas it was only 14.1 in 1950. What caused that sizable drop of about 1.2 percent?

Dr. WALSH. That drop occurred right before the Korean episode. If you recall, back there, was a period there when it was quite difficult for our people to find employment in the chemical industries. There was a period of 1 or 2 years when total workers was increasing at its normal rate, and yet there was a particular sharp break in employment. You will notice that the total number of workers went down in the petroleum industry at that time, particularly the nonsalaried workers went down quite abruptly. The salaried workers went up a little. I don't think we can say, other than that, except probably there also occurred around that time a break in the number of refineries, with the closing of several small refineries.

I was about to comment that there are approximately 700 workers per refinery, and I believe that this would be characteristic, relatively, independent of the size of the refinery. The 700 workers would probably be divided into a group of supervisory workers, and then probably 4 shifts of operating workers. I talk of 4 because you appreciate that around the clock there are 3 8-hour shifts, but to cover 7 days you must have a shift break, and the fourth shift will come in.

Another thing you might wish to note in this particular industry, the petroleum industry, is the investment per worker. The best estimates for 1953—these are Petroleum Facts and Figures type data—indicate that there is about $3 billion in net investment in the petroleum industry, and $5 billion 800 million in gross investment. I believe the difference between the two takes into account depreciation. These figures would amount to about $15,000 per worker, or $29,000 per worker, invested in the industry.

However, current replacement investment figures indicate a new plant cost of about $43,000 per employee in the industry.

The CHAIRMAN. That is about four times the average, isn't it?

Dr. WALSH. Well, it is possibly more.

The CHAIRMAN. Possibly more. And, in other words, this industry probably has more investment per employee than any other industry that I know of.

Dr. WALSH. I believe so. To my knowledge, it is the highest investment per employee of any large group.

The chemical industry has followed a similar pattern, for the volume of production and the production and nature of chemicals permits that operation. Sulfuric plants are largely automatic, as are most bulk chemical plants, chlorine, ammonia, and things moving in bulk volume, automatic recorders, motor valves and responsible skilled operators are typical of these plants.

However, other parts of the industry producing a wide variety of products in smaller quantities do not find the continuous plant possible. They operate batchwise with manual operations at each step of the process. Organic dye plants, special chemicals, and high value small bulk materials characterize that part of the industry.

This means that it is not possible to take the industry as a whole and analyze it quite as thoroughly as we can the petroleum field. However, we do find in the chemical industry the capital investment per worker is very high. Figures for 1951 from the Manufacturing Chemists Association indicate that the capital investment was about $40,400 per worker, including capital, petroleum, and coal. We have already seen what the petroleum industry was so we have to consider the chemical industry as somewhat less. This compared with about $14,000 in the food and beverage industry, or $11,000 in the automobile industry.

The chamber of commerce in a United States survey showed that since 1945 9 chemical companies have invested an average of $38,000 per job in constructing new facilities. Data from the Securities and Exchange Commission indicates that between 1945 and 1954 the petroleum industry's capital expenditures were 22 percent of all manufacturing industry's capital expenditures. Another 9 percent of the expenditures were made by the chemical industry.

I have noted that during this period the employees in these industries were 1.5 and 5 percent, respectively, of all workers.

Within the chemical industry the trend has been toward larger plants. However, this is camouflaged by the initiation of small plants for the manufacture of new products. In 1952, 96 percent of all chemical plants had fewer than 249 employees. These plants employed 38 percent of the total persons in the chemical industry. If you will look at table 3 on page 5 you will note that through the years the number of employees per plant in the chemical industry has increased from 22, in 1900, to approximately 70 in 1955. That is average, and the number is small because of the tremendous number of small chemical plants.

Senator O'MAHONEY. Do you mean independent?

Dr. WALSH. Not necessarily independent, but small in that they are beginning with new products in a small way, to start something that may not have been made before.

Senator O'MAHONEY. This column entitled "Chemical plants" is not therefore to be understood as indicating the number of corporations?

Dr. WALSH. No. This is the number of plants.

Senator O'MAHONEY. Many of these plants may be managed by the same managerial force?

Dr. WALSH. Top management.

Senator O'MAHONEY. Yes.

Dr. WALSH. Yes. However, there will be a local management in practically every plant of some order.

Senator O'MAHONEY. But subsidiary to the national management?

Dr. WALSH. That is right.

Senator O'MAHONEY. This table, then, is not to be understood as indicating that in 1953 there were anything like 11,000 separate chemical operations of separate ownership in the United States?

Dr. WALSH. That is right.

The CHAIRMAN. Can you make an estimate of the number of separate ownerships?

Dr. WALSH. In 1950 the figure was 8,300.

The CHAIRMAN. Eleven thousand chemical plants are listed here. I don't know too much about your industry, but my guess would be it would be two or three thousand. Do you think that would be too low?

Dr. WALSH. I would think that would be too low.

The CHAIRMAN. You think five or eight thousand, somewhere around there?

Dr. WALSH. I would think 8,000 would be closer. My first guess, I believe I said eight to nine thousand.

The CHAIRMAN. I believe you did.

Dr. WALSH. I don't have facts for that. I am guessing.

Senator O'MAHONEY. Don't you know, Professor, that there has been a very great increase in the number of mergers in various fields, and that these mergers are not excluded by any means from the chemical industry?

Dr. WALSH. I appreciate that. There have been.

Senator O'MAHONEY. Isn't it a fact that there are a few very large chemical corporations which operate numerous plants in various parts of the country?

Dr. WALSH. There are quite a few, but that is also characteristic of a large company, such as the du Pont Co., which we consider as operating numerous plants. I believe it lists 127 plants that they operate.

Senator O'MAHONEY. That is right. That is what I am driving at.

Dr. WALSH. There are very few orders of that order of magnitude.

Senator O'MAHONEY. How about American Cyanamid?

Dr. WALSH. There are about a dozen corporations operating perhaps 25 to 100 plants apiece.

Senator O'MAHONEY. Suppose we call that 50. That would be 600 plants, wouldn't it?

Dr. WALSH. That would be 600, but that still leaves tremendous room for small companies who are just getting started, and quite frequently you will find that many new products are brought out by very small companies, with, I agree, 2 or 3 employees, but they are just getting started.

Senator O'MAHONEY. In new fields?

Dr. WALSH. Always in new fields. There are a few fields that new companies start small, but the bulk chemical manufacturer, taking as an example something of the nature of Urea, where it will take an investment of millions of dollars to get started, you will not find a small new company doing it. It is going to be a big one.

The CHAIRMAN. This includes plastic plants, too, doesn't it?

Dr. WALSH. Plastic plants are characteristically small other than the raw material for the plastic plants.

The CHAIRMAN. Are there many small plastic plants coming into being now, being organized and going into production?

Dr. WALSH. I believe there still are.

The CHAIRMAN. You mean for manufacturing purposes?

Dr. WALSH. Yes, sir.

The CHAIRMAN. What do they manufacture? Do you know of a variety of things, like sold in the 5-and-10-cent stores, like spoons?

Dr. WALSH. Spoons, combs, dishes, and things like that.

The CHAIRMAN. Lots of them are making things like that?

Dr. WALSH. Yes.

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The CHAIRMAN. They get their basic raw materials from these chemical plants?

Dr. WALSH. They get the basic raw materials from the chemical plants.

The CHAIRMAN. That industry is spreading rather rapidly, isn't it?

Dr. WALSH. Very rapidly.

The CHAIRMAN. And I guess freight rates add to the importance of an industry of that type?

Dr. WALSH. Yes.

The CHAIRMAN. And storage facilities. I would think that a concern like Kress or Penney, or any of the large national retail chain outlets, it would be to their convenience and benefit to have a local plant supply them because of the freight rates and storage?

Dr. WALSH. Are you talking about the finished products that are being supplied?

The CHAIRMAN. I am talking about the finished product.

Dr. WALSH. That is true. The finished product and processing is characteristically being done in your centers of population, with the small market area about the manufacturing plant. The raw materials for that industry are being made in a few spots, in continuous or semicontinuous operation in like quantities.

The CHAIRMAN. I assume that there are only, say, half a dozen places in the United States where the raw materials are made; is that right?

Dr. WALSH. Half a dozen would be a fair estimate, of any particular one. You have got several plastics, and the raw materials will be made in different spots.

The CHAIRMAN. I guess du Pont makes a large percentage of them?

Dr. WALSH. Du Pont makes a lot, Dow makes a lot, Carbide & Carbon makes a lot.

The CHAIRMAN. You may proceed, sir.

Dr. WALSH. I was talking about the figures on page 5.

I was indicating that there has been an increase in the number of chemical plants, and that included these multitude of small chemical plants which are being initiated and growing each year.

There has also been an increase in the value added to the product by the plant, or by the employee, so that by 1953 we find that each employee in a chemical plant is adding an average of about $12,000 to the value of the material; that is, finished products would be worth, perhaps, an average of $12,000 more than the raw materials, and that has increased through the years.

Senator O'MAHONEY. How about the compensation per employee?

Dr. WALSH. That has also increased through the years. I have a figure over on page 7, or a table on page 7, in which I indicate the compensation per employee for all manufacturing, chemical, and petroleum industries, showing the hours per week worked and the dollars per hour that was paid to the nonsalaried employees.

Senator O'MAHONEY. Would it be possible to work out another column for table 3 showing the total compensation, or the average compensation per employee?

Dr. WALSH. That would be possible.

Senator O'MAHONEY. This is a very interesting figure that you have there in that column.

Dr. **Walsh.** It would be the product in the chemical industry in table 7, the product of the 2 numbers.

Senator **O'Mahoney.** Which two numbers?

Dr. **Walsh.** If we talk about 1955, for instance, we find in the chemical industry that we have an average workweek of 41.4 hours per week, with $1.99 an hour. If I make that $2 an hour to speed up the calculation, in 41 hours a week that is $82 a week, and if we multiply that by 50 weeks, allowing round numbers——

The **Chairman.** About $4,100?

Dr. **Walsh.** $4,100 would be the return to the employee, for which he is adding a value to the industry, to the national economy, of $12,100.

The **Chairman.** How much?

Dr. **Walsh.** $12,100. Is that the figure you were asking about?

Senator **O'Mahoney.** Yes. Then in 1953, the column from which you select the hours per week shows, for 1953, 41.2?

Dr. **Walsh.** And 183. That would be about $4,000 in 1953.

Senator **O'Mahoney.** Do you have any opinion as to the meaning of this, the significance of it, namely, that this table would indicate that the average employee adds 3 times his compensation to the product, the value?

Dr. **Walsh.** That would seem to be what it is. That is about what it is indicating, and I do not——

Senator **O'Mahoney.** Do you think that is good or bad, as compared to other industries?

Dr. **Walsh.** I think that is probably a reasonable ratio.

Senator **O'Mahoney.** How much of it is due to automation?

Dr. **Walsh.** Appreciable amount of it, because this employee has the advantage of these automatic tools. He is able to use his efforts to a great extent, and accordingly he is able to achieve this large increase in value, and from that he is able to receive an appreciable return.

Senator **O'Mahoney.** Have you made any effort, in your own researches, to compare the additional value per dollar of salary with that in other industries?

Dr. **Walsh.** I have not made a quantitative comparison, but I believe that it is high in this industry.

All manufacturing

Year	Value of manufacturing dollars per employee	Compensation dollars per employee
1939	$3, 110	$1, 150
1947	6, 250	2, 550

Senator **O'Mahoney.** The chemical industry is likely to be much higher than any other?

Dr. **Walsh.** Yes, sir.

Senator **O'Mahoney.** Do you think it would be higher than the petroleum industry?

Dr. **Walsh.** If anything, it would tend to be lower than the petroleum industry.

Senator O'Mahoney. In other words, you think automation increases the value more in the petroleum industry than in the chemical industry?

Dr. Walsh. Yes, because we have an industry that has been able to take advantage of automation to a higher extent.

Senator O'Mahoney. What is the effect in the chemical industry of automation on the number of employees?

Dr. Walsh. In any specific process, the number of employees seems to remain about constant, while the productiveness of those employees has increased tremendously. Now, there are specific examples which we can have, where the number of employees has been reduced, but they have been shifted to other processes, also, in the chemical industry. The industry has in general employed about the same percentage of the available labor market through the years. It is just about 5, and the chemical industry seems to be employing that 5 percent almost every year.

The petroleum industry is actually employing a somewhat smaller percentage, as I have already indicated, but the number of employees is increasing.

Senator O'Mahoney. Perhaps it would be helpful if you would prepare an additional table amplifying these matters that have been the subject of our colloquy, unless you have already got it.

Dr. Walsh. We had such a table.

The Chairman. Suppose you insert it in connection with your remarks.

Dr. Walsh. It can be put together very quickly.

The Chairman. That will be fine.

(The following table was later received for the record:)

Year	Manufacturing industries total employees (1,000's)	Petroleum employees (1,000's)	Industry percent of manufacturing	Chemical employees (1,000's)	Industry percent of manufacturing
1940	10,780	437	4.1	159	1.5
1945	15,302	711	4.6	201	1.3
1950	14,967	682	4.6	238	1.6
1951	16,104	749	4.6	253	1.6
1952	16,334	770	4.7	254	1.6
1953	17,238	807	4.7	260	1.5
1954	15,989	791	5.0	253	1.6
1955 (June)	16,481	810	4.9	254	1.5

May I make one observation: Senator O'Mahoney was bringing out the added value of the workers' efforts by reason of manufacturing.

Dr. Walsh. Yes.

The Chairman. Of course, we must take into consideration there, too, that the worker in this particular industry has about $43,000 worth of equipment and tools per worker to work with.

Dr. Walsh. That is right.

The Chairman. Whereas the average worker in the manufacturing plant would have only about ten or eleven thousand dollars' worth of equipment and tools to work with, and the average worker here, having about $43,000 worth of equipment and tools to work with. His earnings are about 10 percent of that each year, if I properly evaluated what you said; is that correct?

Dr. Walsh. That is right, yes. I believe that added value of tools to work with has increased the worker's productivity, and I think that is part of this large value added to the economy by the workers in this particular industry.

I wanted to comment, and the way I chose to do it was a short story, about an additive which I saw advertised in the industry a few years ago. This additive was to be used in lubricating oil. Laboratory tests showed that it made a better motor oil than anything else on the market at the time; just in laboratory testing engines in cars. The company decided to manufacture it and put it on the market. The men in the research lab, and the development engineers, would very much have liked to have a continuous process for this particular additive, but the company—and it was a reasonably large company—was selling a total of about 800 barrels of lubricating oil a day, of which about 300 was the quality that they would expect to put in this new additive. The additive would be needed in about 1 percent. That means that about 3 barrels of additive a day, or 21 barrels of additive a week, was enough for their supply. That was all they needed.

Now, you cannot very well operate continuously around the clock in an operation and make 21 barrels a week, so it was decided that we would make the additive in a batch kettle. The process was worked out, and the operator started manufacturing, but within a few weeks, about 2 weeks after the process plant had been put into operation a minor explosion indicated that perhaps the way it was being handled was not safe. The plant was closed, the sales department was in an uproar because they didn't have the new and better product, but a device was worked out by which all operations in this plant could be controlled from a distance, and in this particular case the drums of chemicals were picked up by long-range fingers and emptied into the kettle, thereby protecting the operators from the hazard of potential explosions.

I also want to comment that this particular additive was made obsolete within 6 months by the discovery of a better additive for a still better lubricating oil, and the whole project was abandoned.

I have several points on this. One is that when you have a new product that you want to get into manufacturing, and you find that you need 20 or 50 or a hundred barrels a week, it does not pay to go into a continuous operating plant. I also want to indicate that the reason for using automation in this particular case was the safety of the operators. It was more expensive to do it, using mechanical equipment, than it was to have men empty the drums into the kettle.

I also wish to indicate the hazard that accompanies new investment in this particular area. Here is a plant, which put on a new product, 6 months later the product is valueless because you have something else that is better.

There are and have been for perhaps 10 years about 400 new chemical products introduced to the market each year. This does not mean a total of 10,000, or 4,000, because many of those have become obsolete, or for one reason or another did not prove practical. However, in many of these new products you will find that the initial plants will be small and will not be automatic. These were the things I was talking about earlier.

We perhaps can sum up, then, by saying that safety has been a large factor in the automation of the chemical industry. You will hear about the plants, such as a plant for making polyethylene, that is almost completely automatic, and if you check into the process you will find that it is desirable to make polyethylene at pressures at 10,000 pounds per square inch to 25,000 pounds per square inch. This is one of our new basic raw materials.

I suspect you are all familiar with the polyethylene products. The reason for making the polyethylene raw materials manufacturing process purely automatic was in the first instance the safety of the operators. However, you find when you do make a plant of this nature automatic you get better quality material. Your variation in yields are smaller. Your variation in quality is smaller. Your operating efficiency generally is greater, and your possibility of error has been reduced.

I wanted to point out that the benefits of automation have been shared by many groups of our society. We might quote the public. The public, I believe, has benefited greatly from automation in the chemical and petroleum industries. The investors have benefited. The workers have benefited, and I believe even the Government has benefited. If I can use again the petroleum industry as an example, the public has benefited because the average service station price of gasoline before taxes is today within a cent of what it was in 1925.

The investors have benefited, in spite of the great outlay of capital, because their returns have been preserved, their dividends have regularly been paid in most of the large petroleum companies through the years.

The workers have benefited because they are earning at the present time an average income that is higher than workers in all manufacturing industries taken together. They are not working shorter weeks. They are working, if anything, a longer week. Now, the difference in length of workweek is small but if you check it you will note from my table 4 that the average number of hours worked in the chemical industry, and in the petroleum industry, is greater than that of all manufacturing, and also their hourly income is higher. The product of the two indicates a greater yearly return to the workers in these industries than from the manufacturing industry, in general.

I might add that the taxes that have been added to the petroleum products since 1925 now are averaging about 7 cents a gallon for gasoline across the country, and that is a combination of National, State, and local taxes. The industry has been able to carry the burden and has paid these taxes, partly out of the benefits that have accrued to the industry from increased automation.

Now, that is as far as I have a prepared statement.

The CHAIRMAN. Your statement is very fine. We certainly appreciate it very much.

(The complete statement of Dr. Walsh appears at the end of his testimony.)

The CHAIRMAN. Senator O'Mahoney, would you like to ask some questions?

Senator O'MAHONEY. Not any more.

The CHAIRMAN. Would you, Mr. Moore?

Mr. MOORE. These figures which you quoted of $43,000 in capital investment per employee are, of course, averages. Is there any realism to a clipping that I have here in front of me that talks about the Dow Chemical Co.'s Madison mill as illustrative of the hypothetical possibilities of automation in creating unemployment? Cost ing $40 million, the plant uses a total production force of only 400 including maintenance and instrument men to work around the clock and produce 66 million tons of magnesium products. That is $100,000 of capital per worker.

Dr. WALSH. That is right.

Mr. MOORE. Is that typical of modern up-to-date plants at all, or is it an extreme?

Dr. WALSH. I believe that is an extreme. There are certain reasons why automation was used in that particular plant. Magnesium is being made from sea water. Here we have a situation where we have a tremendous supply of a common raw material, not expected to change appreciably in composition through the years, that is being used to make a specific single product. Quantities of material to be handled are tremendous, and the materials are flowed right up to the final point where the magnesium is made and poured into bars, after which it is handled, of course, batchwise, on pallets, and so forth.

I might comment, however, that I do not think this is a case of a possible loss of employment, but yet rather a gain of employment for 400 people, because without the possibility of doing it in some such system as this, Dow would not now be making magnesium from seawater, and magnesium is a particiular product which has been of great benefit to the country during war periods, and is pretty much of a drug on the market during peacetime periods.

The CHAIRMAN. Mr. Ensley?

Mr. ENSLEY. No, thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much. We appreciate it. If you want to elaborate on your statement you may have the privilege of doing so.

Dr. WALSH. I would like to make a further statement, if I might, about our automation project at Case, and some of the things we found in it.

A group of us got together a few years ago to see what we could do about further automizing the chemical processes. We began an investigations. So far we have pretty much reached the conclusion that as far as touching currently operating processes, we have very little to offer. The industry is operating in what you might call the semiautomatic, what I call this open loop process, where men are in control. They are operating very effectively, and very efficiently. The experience of their operators is invaluable to them, and I believe that these men are going to become more valuable as they learn more about the work. They know everything about their plants that you might ever hope to build into a thinking machine, if you want to put one on.

I think we have an advantage and what I think we can do in the future is to provide techniques and provide materials for new processes that are not currently operating, and that you might think we are today dreaming about when we consider them. Acetlyene would be an excellent raw material for making many new chemicals, and I cannot say all of them. To make acetylene from natural gas we will have to crack it in the order of 1.3 seconds. Right now we cannot control the process. It gets away, and we wind up with carbon black and hydrogen, and they might be desirable, but they are not as valuable as acetylene. A high-speed computer that can figure out in a thousandth of a second what was going to happen under these conditions would have a jump on the process that takes 1.3 seconds. A man just doesn't think that fast. We cannot learn that much about it, and I believe that this is one case, one situation, whereby automatic plants in the future, with high-speed computers, deciding what the operating conditions should be, are going to become a possibility. I think our future is in new products which will offer more to the economy, will offer employment to more new people, rather than in replacing current operating employees.

Senator O'MAHONEY. Then you are saying, if I understand you, Professor Walsh, that the push-button machine works so much faster, and can be made to work so much faster so far as computation is concerned than the human mind, that it can produce things which are not capable of being produced now because of the lag of human thinking behind the automatic computing machine; is that right?

Dr. WALSH. That is right.

Senator O'MAHONEY. Then do you wish to say whether or not in your opinion the standard of the intelligence of the operator of an automatic machine will be raised or lowered as automation proceeds?

Dr. WALSH. The operator will probably have the same standard of intelligence as your operators have today, and I consider the standard of intelligence of the chemical plant operator is high. I don't think the operator will need to know more than he does now.

Now, the designer of the machine is going to have a high level of intelligence, so that he can direct the machine as to what it will do when certain things occur.

Senator O'MAHONEY. To make a comparison, an infantile child who doesn't understand a thing in the world about an automobile can drive an automobile, and sometimes safely; is that right?

Dr. WALSH. Sometimes safely; generally not, yes.

Senator O'MAHONEY. I am not one of those who attempts to classify drivers as between men and women. I don't do that. I have known many very excellent women drivers, but I know that most drivers don't understand a thing in the world about an automobile engine; is that right?

Dr. WALSH. You are right.

Senator O'MAHONEY. Isn't that true of automation at large?

Dr. WALSH. Oh, yes; that is generally true.

Senator O'MAHONEY. Well, as automation proceeds will it be necessary to demand a higher standard of intelligence, or a better education of the operator than is now required?

Dr. WALSH. I do not think so. The operator will operate with his standard of intelligence, as we get the run-of-the-mill people. There will be a natural selection, and where the operator is required to have a higher standard of ability, or intelligence, natural selection will take care of the person, but, on the average, I would say "No."

Senator O'MAHONEY. The old-fashioned mechanic who, with his hands, performed the entire operation was very proud of his accomplishment; his duty and responsibilities were very different from that of the operator of a push-button machine who, in many instances, merely performs over and over and over again the single operation. Isn't that right?

Dr. Walsh. Yes.

Senator O'Mahoney. The former was necessarily a person of very high standard of intelligence and mechanical ability. The latter is required only to learn a single operation, and he requires no greater education or knowledge than to do that one thing. Is that not a fact?

Dr. Walsh. I believe you are trying to consider here that the operator of this, as you call it, push-button machine is going to be pushing a single button, and I don't think——

Senator O'Mahoney. I was coming to that. Of course, I recognize that there are different kinds of machines. I was just approaching that step by step.

Dr. Walsh. I can think back to one of the days when I was a younger engineer first working in a refinery. I went out to run a test on a cracker. We wanted to run the test at the highest throughput rate possible on that particular unit. It was approximately 40 percent above design when we finally ran our test. As we got there that morning the operator, as we call them, the man in charge of that unit, he had a crew of about four working for him, but he was an operator—we began inching up the cracker slowly on his control panel, changing setting of the valves, et cetera. He was relieved at 3 o'clock that afternoon.

The new operator came on, who actually was the oldest operator in the particular gang that were operating this plant. We had gone from about 15,000 barrels a day to 18,500. He said, "Well, we can do more than that," and he pushed it to 23,000. In about a half hour he pushed it to 23,500 and he said, "Boy, that is as far as you are going to go."

I have great respect for his intelligence, and he was changing a setting on a dial controlling the plant designed for 15,000 barrels a day of aviation gasoline to make 23,500 at that moment. Have I helped to answer your question?

Senator O'Mahoney. He was handling numerous movements, not one?

Dr. Walsh. Yes.

Senator O'Mahoney. In order to bring about that increase?

Dr. Walsh. He was handling numerous movements, but essentially that was the change of one particular setting on one particular control that brought that about.

Senator O'Mahoney. How many settings and controllers did he have to operate?

Dr. Walsh. One.

Senator O'Mahoney. That, I think, would fall into the category that I call the push-button. Now, I am thinking of the panel of a jet airplane. I have seen that, and I could compare it mentally with the panel on the first airplane I ever flew. It is much more complex and requires a great deal more attention by the pilot than the other.

Dr. Walsh. I would like to compare this control room to the panel of that jet plane. It was a room about 30 feet long and 30 feet across, with instruments on both side walls and across the front. The instruments were a double tier with special readings in a third tier above. The operator's desk was in the center.

Senator O'MAHONEY. He had to operate only one control.

Dr. WALSH. But he had to know what all of them were doing when he did it, just like the pilot operates one button to increase his speed.

Senator O'MAHONEY. That requires a very high skill.

Dr. WALSH. That does.

Senator O'MAHONEY. And it requires much more ability and intelligence than is necessary for the person who, in an assembly line production, just does a certain particular function.

Dr. WALSH. That is right.

Senator O'MAHONEY. Automation divides itself into these two different classifications, then.

Dr. WALSH. You are probably right there, yes, sir.

Senator O'MAHONEY. But all in all, your opinion, from your investigation in the petroleum field and in the chemical field, is that automation not only increases productivity per individual, but increases compensation for the individual and creates more opportunities for jobs; is that right?

Dr. WALSH. Yes.

Senator O'MAHONEY. Do you have any doubt about that at all?

Dr. WALSH. No.

Senator O'MAHONEY. None whatever?

Dr. WALSH. No. I am convinced. That is why I am working on it.

Senator O'MAHONEY. Do you think those operations, those industries concerning which you have testified are different from other industries in which automation is possible?

Dr. WALSH. I believe that they have already possibly passed the point that is causing you concern. The point where automation may have reduced jobs in the industry might have been some years back, although we have seen no record of it as we follow the history of employment of the industry. But I think we have now reached a point in these industries where automation is going to expand things, rather than cause difficulty with people going out of work.

Senator O'MAHONEY. Do you think that automation will automatically expand opportunities for employment?

Dr. WALSH. No. Every case has got to be studied.

Senator O'MAHONEY. And something has got to be done to make sure that automation will expand opportunities for employment as it grows?

Dr. WALSH. I think part of what is being done is the thing we are doing, where we take a case and we investigate it, and in particular we decide that this case is not for automation, and then we look at something else and we decide that this is for automation, and the things that we see——

Senator O'MAHONEY. I would like to have a paper on that very distinction, and let us know what it is. I don't want to examine you about it and have your extemporaneous response. I would like to have you think this over and submit to the committee a thoughtful statement on the very point that you raised.

Dr. WALSH. We have thought of it much. I am not talking without thinking, as you appreciate, on this point.

Senator O'MAHONEY. No. Of course, I wouldn't suggest that. I am sure that you are not a pushbutton witness.

Dr. **Walsh.** If I was able in all cases to say exactly what would be for automation, I would be doing much better than teaching in college, I suspect.

Senator **O'Mahoney.** I don't know of any better pursuit a man can have than teaching college.

Dr. **Walsh.** Thank you. But what we have found is that as we study the currently operating processes, we find that automation has improvements to offer to the extent of 1 or 2 percent, and we do not think the extra investment is worth that. The things that we dream about—you are asking me of the paper—the things we dream about, I can assure you we have such a report of our project to be made by about the first of January.

I don't know whether that is soon enough for your committee or not.

Senator **O'Mahoney.** Congress won't be in session until after the first of January, according to the present outlook, so I think that that would be very valuable when it is ready.

Dr. **Walsh.** We will have that for you about the first of January, if that is satisfactory.

Senator **O'Mahoney.** Thank you very much, Professor Walsh.

The **Chairman.** From the time that you receive the transcript until you return it, you will have about a week or 10 days, and if you want to elaborate on your testimony to answer the questions further, we would certainly like for you to do so.

Dr. **Walsh.** Thank you.

The **Chairman.** I would like to ask you just one question. Considering what you have said about creating new jobs, etc., and considering the fact that our population will increase between now and 1965, and we will probably have about 190 million people then, what is your prediction as to the length of the workweek that will be required at that time? Do you think it will be shorter, do you think it will be longer, or about the same, as compared to the 40-hour week now, to maintain maximum production and employment?

Dr. **Walsh.** I believe it will be about the same. I do not think it will be any larger. I do see that it may go down some. There have been times I am familiar with where in the petroleum industry they were working a 36-hour week. I don't think it will be below that. I would suspect it to remain about the same—38 to 40 hours.

The **Chairman.** Thank you very kindly, sir. We appreciate your testimony.

(Dr. Walsh's prepared statement follows:)

AUTOMATION IN THE CHEMICAL AND PETROLEUM INDUSTRIES

By Thomas J. Walsh, Department of Chemistry and Chemical Engineering, Case Institute of Technology, Cleveland, Ohio

The petroleum industry is considered by many to have applied automation to the greatest extent of any industry. The chemical industry is nearly as automatized. We will use these industries as case studies into the effect of automation.

These industries are distinguished from most other industries in that they both process materials that are mainly fluid (gas or liquid) rather than solid. Where solid materials are handled they are frequently powdered or otherwise finely divided. The characteristic tendency of a fluid to flow permits the handling and processing of the materials in pipe or ducts. Devices for controlling the flow and measing changes in the material during the operation made possible continuous operation. This continuous operation is the process plant equivalent of automation. It was a growing practice several years before the word "automation" was conceived.

The petroleum industry is more homogeneous than the chemical industry so trends and overall characteristics may be better observed in this area. Typical may be the observation that the production of any unit in a petroleum refinery is not a function of the number of employees working on the unit. It is as easy with automatic controls to control operation of a 20,000-barrel-per-day catalytic cracker as it is to control a 5,000-barrel-per-day catalytic cracker. The average size of a refinery has increased through the years while the number of refineries in the country has decreased. During 1954, seven refineries were under construction with an average design capacity of 56,800 barrels per day. Nonoperating refineries numbered 29 with an average capacity of 7,750 barrels per day. Thus, the trend toward fewer larger refineries is continuing.

TABLE 1

Year	Number of operating refineries	National capacity, barrels per day	Average capacity, barrels per bay
1951	325	6, 701, 815	20, 600
1952	327	7, 161, 366	21, 800
1953	315	7, 481, 701	23, 700
1954	308	7, 782, 103	25, 268

However, the refinery is not a manless plant. The industry has found that the cybernetic plant is not practicable. One reason for this is that a number of persons are desired on hand for special duty and for emergencies. While present, they are available for routine duties and operation. Control is usually what we call open loop with a man in responsible charge of each unit. This operator may be stationed in a central control room with a graphic panel showing him important data from every point of the plant, but he controls the operation. While this brain center gives a vivid concept of the running of the plant, it also must be continuously manned. Other assistant operators about the plant are instructed by loudspeakers or telephone.

The number of refinery employees has shown a small dip and then has risen to new peaks. The total number of workers in the industry has risen almost steadily. Within the refinery the ratio of hourly workers to salaried workers has decreased. Simultaneously the percentage of total industry employees working in the refineries has decreased. Other fields of employment are production, transportation, wholesale distribution, and retail distribution. In these fields automation is less practicable and jobs are created as more petroleum products become available at reasonable cost.

TABLE 2

Year	Refinery employees (thousands)			Industry employees		
	Nonsalary	Salary	Total	Ratio, nonsalary to salary	Total (thousands)	Percent in refinery
1947	141. 5	47. 8	189. 3	2. 95	1, 207. 1	15. 7
1948	147. 0	49. 0	196. 6	3. 00	1, 257. 3	15. 7
1949	143. 5	48. 1	191. 6	2. 97	1, 250. 4	15. 3
1950	136. 0	49. 4	185. 4	2. 75	1, 302. 9	14. 1
1951	143. 3	55. 3	198. 6	2. 58	1, 398. 8	14. 2
1952	140. 2	61. 4	201. 6	2. 30	1, 471. 8	13. 8
1953	142. 4	63. 9	206. 3	2. 24	1, 544. 3	13. 4

The value of capital investment per worker is an elusive figure. Best estimates for 1953 indicate a net refinery and chemical plant investment of $3 billion and a gross investment of $5,800,000,000. These figures amount to $15,000 and $29,000 per refinery worker. Current investment figures place a new plant cost at about $43,000 per employee.

The chemical industry has followed a similar pattern where the volume of the production and the nature of the chemicals permit similar operation. Sulfuric acid plants are largely automatic, as are most of the bulk chemicals plants, chlorine, ammonia, caustic, and others. Control rooms, graphic panels, automatic recorders, motor valves, and responsible operators are as typical of these plant as they are of petroleum refineries.

Other parts of the industry, producing a wider variety of products in smaller quantities do not find the continuous plant possible. They operate batchwise with manual operations at each step of the process. Organic dye plants, special chemicals, and similar high value small bulk materials characterize this part of the industry.

Investment in the chemical industry is consistently high. Using figures for 1951, the capital investment per worker in chemical, petroleum, and coal products was $40,428 per worker. This compares with $14,183 in the food and beverage industry or $11,896 in the automobile industry. A Chamber of Commerce of the United States survey showed that since 1945 9 chemical companies have invested an average of $38,117 per job in constructing new facilities. Other data, from the Securities and Exchange Commission, indicate that between 1945 and 1954 the petroleum industry capital expenditures were 22 percent of all manufacturing industries capital expenditures. Another 9 percent of the expenditures were made by the chemical industry. During this same period, the employees in these industries were 1.5 and 5 percent, respectively.

Within the chemical industry, the trend has been toward larger plants. However, the effect has been camoflaged by the initiation of small plants for the manufacture of new products. In 1952, 96 percent of all chemical plants had fewer than 249 employees. These plants employed 38.5 percent of the total persons in the chemical industry. Since 1945, 3,900 new chemical products have been introduced on the United States market. Many of these are made in small plants, during the early stages of their growth.

TABLE 3

Year	Chemical plants	Employees, average per plant	Value of manufacturing—average		Compensation per employee
			Per plant	Per employee	
1899	7,669	22	$27,000	$1,230	------------
1914	10,698	25	43,000	1,720	------------
1929	9,327	41	186,000	4,550	------------
1939	8,839	46	204,000	4,450	$1,350
1947	10,073	63	506,000	8,100	2,700
1951	10,909	64	750,000	11,700	3,526
1953	11,000	70	850,000	12,100	3,930

The way factors, such as size, affect the design and operation of a plant may be shown by a short story. A few years ago, a company developed a new additive for lubricating oil. The additive proved excellent in tests and a plant was authorized for its commercial production. The researchers and engineers wanted a continuous-operation plant, but the company was selling about 300 barrels per day of oil in which this additive would be used at a level of 1 percent. The need was 3 barrels of additive each day, or 21 barrels per week. This is a not too large batch that could be made in 8 hours in a standard heated kettle. After operating for less than a month, a minor explosion occurred that indicated the batch should be controlled from a distance. The plant was redesigned for the safety of the operators, using remote control for the handling of the chemicals. In this case, mechanical fingers picked up drums of chemicals and emptied them into the reactors. Six months later a new additive, better than the last, made the whole plant obsolete.

With this story, I hope to show that a small plant normally is designed for manual operation. When safety is a factor automation is desirable even in a small plant. I also hope to indicate the hazard of early technical obsolescence of chemical plants.

The developments in the chemical and petroleum industries have shown that as the plants become more automatic the average size of a plant tends to become larger. The number of plants of a given type becomes fewer but new plants

may fill the void with new products. There is a tendency to use more persons with special skills and responsibility, keeping these persons on salary. The total number of employees seems to increase at a normal rate where products are diverse and at a slower than normal rate where products are specific. Investment in automatic plants are high.

Automatic plant operation is frequently inaugurated for the safety of the employees. Other reasons for automation are quality of product and impossibility of control by more normal means. The advantages have proved to be improved plant yield, improved operating efficiency, and better quality of product. The chance of error is reduced, working conditions and safety are improved.

Within these industries the benefits of automation have been shared by all; the public, the investors, the workers, and the Government. The public has benefited by the level price of gasoline and related products during the period since 1925, while the cost of living has increased considerably. The investors have benefited by the dividends which have been maintained over the years. The workers have benefited by steady work under good conditions. Generally, the workweek of either petroleum or chemical workers has been slightly longer and the pay scale better than other manufacturing industries. The Government has benefited from the taxes that have been paid by the industry and the consumers of its products.

TABLE 4.—*Hours worked and income*

Year	All manufacturing		Chemical		Petroleum	
	Hours per week	Hourly rate	Hours per week	Hourly rate	Hours per week	Hourly rate
1950	40.5	$1.46	41.5	$1.51	40.9	$1.83
1951	40.7	1.59	41.6	1.63	40.9	1.98
1952	40.7	1.67	41.2	1.71	40.6	2.09
1953	40.5	1.77	41.2	1.83	40.8	2.21
1954	39.7	1.81	41.1	1.91	40.8	2.27
1955 (June)	40.2	1.84	41.4	1.99	41.3	2.36

Senator O'MAHONEY. Mr. Chairman, I regret to say that I have a conference coming on at 3 o'clock, to which I find I am late.

The CHAIRMAN. We appreciate your staying as long as you have.

Senator O'MAHONEY. The staff of the Standing Subcommittee on Patents is treating with a subject which is closely related to this subject, and I hope you understand why I have to leave.

The CHAIRMAN. Thank you, sir.

We have with us Mr. Ralph E. Cross.

I understand, Mr. Cross, that your company is one of those which designs and creates assembly lines and transfer machines, especially used in the automotive industry.

We have heard from previous witnesses about these cylinderhead lines and Plymouth motor line and the cylinder block lines for various of the new model cars.

Since your company, like that of W. F. & John Barnes, whose representative we heard day before yesterday, is engaged in the production of automated machines, I am sure we can learn a great deal from your experience. We are especially interested in getting your views as to what the future may hold in terms of further automation.

Mr. Cross, we are mighty glad to have you. You may proceed as you desire.

STATEMENT OF RALPH E. CROSS, EXECUTIVE VICE PRESIDENT, OF THE CROSS CO.

Mr. Cross. Thank you. First, I would like to explain my background.

In our company I am responsible for sales, engineering, service, advertising and public relations. I have been in the business of making automated machines for 23 years.

To begin, I think I would like to start out as most witnesses do, I presume, by giving a definition of automation. I like to think of automation as being the application of cost-reducing machines and techniques. I would like to put some emphasis on the words "cost-reducing" and distinguish it from laborsaving, which I will get into later.

This definition, of course, is a very broad one, but with all the popular concepts of the word that exist today, I think we need a broad definition if we are going to talk about it.

The motivating forces for the application of automation that I have found are: higher wages, lower prices, higher profits, improved product quality, and greater safety.

Automation in the metalworking industry has been in existence for over 100 years. It actually goes back to the time when the first basic machine tools were invented.

I am very thankful to have this opportunity to come before this committee, if for no other reason than to deglamorize perhaps a little bit this concept of automation that has been publicized so much in the public print.

Actually, the word has been overglamorized. In descriptions of automated machinery I have seen the word "robot" used thousands of times, and I think you probably have heard it until you are sick of it. Still at the same time I have never seen a robot. I don't know if anyone has ever seen one, and I don't know of any engineer or any company that is trying to create one.

We hear about these machines that are self-correcting, self-operating, that work all day and never make a mistake, but yet I have never seen one. The New York Post printed a report from a worker at the Ford factory who was transferred from the old foundry machine shop to the new automated engine plane. I would like to read what this worker says to substantiate my point:

Stanley Tylak was his name. He said, and he is referring to an automated machine in the engine plant:

> The machine had about 80 drills and 22 blocks going through. You had to watch all the time. Every few minutes you had to watch to see if everything was all right. And the machines had so many lights and switches—about 90 lights. It sure is hard on your mind.
>
> If there is a break in the machine, the whole line breaks down. But sometimes you make a little mistake, and it is no good for you, no good for the foreman, no good for the company, no good for the union.

Now I would just like to say if these machines are operated by these giant brains that we hear about, if they get their directions from magnetic tapes and punched cards, and if they work all day long without ever making a mistake, what was the matter with Stanley Tylak? The facts are that automated machines do not function as you have been led to believe that they do. The human being, in my

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experience, is the most important element in the operation of an automated plant. I don't see how we could possibly get along without him.

Now I would like to show you a few examples of some automated machines that we have made, to give you an idea of just exactly what we are doing. If we could have the first picture, please. This is what we call sectionized automation. It is a machine for making V–8 cylinder blocks for one of the automobile companies. It is 350 feet long, and performs 555 operations. The parts enter the machine at the left, where the operator is standing. They are automatically transferred from station to station, located and clamped, different operations are performed at each station, the parts progress toward the rear and then cross over and come up on the right-hand side and when the 555 operations are completed. They are ejected at the right.

This machine is operated by a crew of 3 men, 1 direct labor operator, and 2 toolsetters.

The idea of sectionized automation comes from the necessity for being able to shut down some of the operations without stopping the others. The machine is divided into five sections so that some of these sections can be shut down for changing tools and making minor repairs, without having a complete shutdown of the entire machine.

The big problem in a machine like this is the tool changing programs. The tools must be changed regularly, and, of course, this interrupts production and causes delay. The tool-changing programs in this machine are governed by seven machine control units similar to the unit shown in this figure 2.

That is the unit, the picture on the left.

For every tool in the machine we have a little instrument called a toolometer, which is shown there (fig. 3). The toolometer keeps an account of every operation that the tool performs. When the program for the tool expires, the toolometer reaches its zero point, and shuts off that section of the machine that the tool is operating in. The toolsetter proceeds to that section to change the tool. As soon as the section stops, the work is banked up ahead of the interrupted section and conditioned parts are fed into the section that follows the stopped section. This permits some production without stopping the entire machine, while one tool is being changed. When the toolsetter has changed the tool, he resets the toolometer to its starting position and the section goes back into operation.

Basically, the toolometer is a very simple memory device. It tells the toolsetter when to change the tools. We developed it because it would be impossible for the toolsetter to keep a mental account of the five-hundred-some tools that are in this machine and all of their different programs, because every tool has a program of its own.

Sectionalized automation, as you see here, is used for the mass production of complex parts. It would not be profitable to use sectionalized automation on parts of simple design (we have other types of machines to do the simpler jobs), nor would it be profitable to use it on job-lot production.

The next illustration (fig. 4) shows a transfermatic for making tractor rear axle housings. The drawing at the top of the illustration shows the complete setup. It produces 46 housings per hour, at 100 percent efficiency, and by the way, when I say 100 percent efficiency, I don't mean to infer that these machines run at 100 percent efficiency. It is only our way of describing what their capacity is. They operate at efficiencies ranging from 70 to 80 percent.

This machine takes the castings as they come from the foundry, and when it is through with them, the castings are ready for assembly. It is divided up into four sections. The section on the right is where the castings start. They are put into a fixture and go through the operations at that point, are returned to the starting point by the conveyor, removed from the fixture, proceed to the second section, third section, and finally to the fourth section.

The machine is operated with five direct labor operators. It could be operated with 2 workers, 1 direct labor operator and 1 toolsetter, but it would be necessary to provide additional mechanization to handle the work and position it between sections.

In this particular case, an analysis was made of such mechanisms and it was found that the mechanization cost would exceed the labor cost, and consequently the mechanization was not added.

Now, the next illustration (fig. 5) is of a transfermatic for assembling the new 1956 Plymouth Qualimatic V–8 engine. It is difficult to see the detail of this machine, because it is large and it is impossible to take a picture of it. It is installed in the new Plymouth engine plant, which is probably the newest automated plant in the automobile industry. The plant has only been in operation for a couple of months. At the top of the picture, the line that you see there is 560 feet long, and up at the very top is a shorter line for the cylinder heads, which is 126 feet long. There are 2 of these lines, 1 for assembling the right-hand cylinder head, 1 for the left-hand cylinder head. The cylinder block starts at the left and as it progresses from station to station, different parts are added, the cylinder heads feed into the line eventually, and there is a completed engine when it is all through.

There are 198 stations altogether for the whole machine.

These pictures at the bottom, the one on the right, shows a mechanical unit for tightening the cylinder-head bolts and on the left is a unit which positions the crankshaft prior to assembly of the pistons and connecting rods, and then there is another mechanical unit which tightens the connecting-rod bolts.

I would like to tell you the story of how this machine came into existence, because I think it will give you a little better idea of some of the economics that we get into in creating a machine of this kind.

This story begins back in October 1954. During one of his visits to the Plymouth plant, our sales engineer received an inquiry for a machine to assemble this new engine. There had been a great deal of discussion in the industry regarding machines for assembling engines, but nobody had ever given the idea very serious consideration. We naturally were enthused about the inquiry, and as a result, we put together a team to see what could be done to sell it. The same day that our sales engineer received this inquiry, we returned to the Plymouth engine plant; that is, the sales engineer, our chief engineer, and I, we returned to the Plymouth plant that day to have a meeting, to discuss the feasibility of making a machine of this character. We sat down around a table and we listened to the ideas the Plymouth engineers had, we contributed what ideas we had ourselves, and we put all this

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data together to start the project rolling. The next day we gave this information to one of our project engineers, and the sales engineer, the chief engineer, project engineer, and myself proceeded to devise a machine for doing this kind of work.

In about a week or 10 days we had many of our ideas converted into drawings, and we took them back to the Plymouth plant to go over them with the Plymouth engineers. At this time many additional suggestions were made, and many new ideas were developed cooperatively.

Also, during this period all of us were circulating amongst the other automobile plants to learn everything we could about what had been done in the past about assembling automobile engines. By the end of November, we had devised a machine which we thought was workable, and which we thought was salable. We estimated the price for it, and we submitted a proposal to Plymouth late in November. When Plymouth received this proposal they began to estimate the cost of assembling the engine with this machine, and compare it with the cost of alternate assembly methods. Of course, the purpose was to determine what would be the best investment, a machine of this character, or conventional assembly methods.

Eventually, we submitted individual prices for every mechanical assembly device incorporated in the machine. I believe I said there were 198 stations in the machine. There is a possibility of having a mechanical assembly unit at every one of those stations. Now, we were unable to devise means for mechanically assembling every piece of the engine, but we had devised many devices, and on those that we devised we submitted individual prices. The purpose of this individual pricing was so that Plymouth could evaluate the economics of applying these mechanical units for each of the individual operations.

Many of the things that we propose were discarded by Plymouth because it was just more economical to do the work by manual operations. An example of that is—you cannot see it from here, at least I cannot—is a device that we had conceived for laying the crankshaft assembly in the engine along about station 14 in the picture. It is a short distance from the left end. That is an example of one of the units that we had contrived—a mechanical device to do the operation—but Plymouth did not buy it because it would not pay for itself.

Well, after all of these evaluations were made, and the units were discarded, which were not economical, we repriced the entire machine and submitted another proposal to Plymonth, and this is what they purchased.

I won't go into all of the details—I have it in the record, and if you care to read it you can—but after we received the order, of course we had the job of making the machine, installing it in the plant, teaching people at Plymouth how the machine operates, working the bugs out of it, and getting it into production.

The first engine came off the end of this machine late in July of this year.

Now, I have talked a good deal about how we submitted individual prices for these units, and I did so for a reason, because what we are trying to do with automation is to lower costs, not necessarily eliminate labor. We have conception drawings in our engineering department for many machines that would reduce labor cost, but much to our disappointment our customers are not the slightest bit interested.

The difficulty with these machines is that they simply do not reduce production costs. The secret of bringing a machine like this into existence, or any other, for that matter, is getting the proper balance between mechanization and labor. Every time a new machine is purchased a decision must be made between more mechanization and less labor, on the one hand, and less mechanization and more labor, on the other.

For example, in the machine in figure 4—where we evaluated the material-handling devices between the sections—we could have reduced the labor from 5 people down to 2 people, but it was not economical, because it would not reduce the cost of the product, so 5 people were employed instead of the 2. On the assembly machine, figure 5, there are practically 100 people working. The number of people could be reduced substantially. I would say, with the technology that we have available today, we could probably reduce the figure in two, but the cost of the engine would go up if we did.

So the objective is not to reduce labor, but to get the proper balance between mechanization and labor, so that we will get the lowest possible part cost.

In all of my experience in creating automated machines,I don't believe I have ever sold a machine that could not have been made more automatic, or that might not have reduced labor further than it did. I think I can sum it up by saying that I have never found a situation to exist where all mechanization and no labor would provide the lowest operating cost. I think that sort of a situation is as extreme as a situation with all labor and no mechanization.

So much for the balance between mechanization and labor. I would now like to go on and develop the idea that technological progress is controlled. It is controlled. It is very definitely controlled. In every manufacturing operation there is an economic point at which time it becomes profitable to replace an old product, or a process, with a new one. Good timing is extremely important, because losses occur from premature replacement of modernization, as well as from delayed replecement. Our next illustration up here, figure 6, will bring this out in greater detail.

This chart shows what happens to a process after it is installed and operating, and here we are talking about profits plotted against years, and I use "profits" because it is a convenient term for discussion purposes. We could talk about economic good, or we could talk about any of the other things that might be associated with profits. Curve A plots the profits per unit of a manufacturing process as it goes through its lifetime. The profits continue to decline until we reach a point where the curve runs off the chart, and it is no longer profitable at all to use the equipment. The decline is the result of obsolescence; from competition forcing the price down; the profit per unit down on the product.

Curve B plots the profits that might be obtained from installing the latest, the most modern, up-to-date equipment that could be obained at the beginning of each year.

Now, the question will probably immediately arise as to why the profits from B are lower than they are from A, in the early years, and this is because, if you were to install a new machine, or a new process, in the early years that machine would have to absorb the loss that would occur from disposing of the comparatively new equipment A, before it was fully amortized.

The difference between A and B, or the shaded section on the left of the chart, shows the loss of profits that result from premature replacement. The shaded area on the right of the chart shows the lost profits from delayed replacement. Now, the ideal point at which to modernize is where the two lines cross. This point, of course, is very difficult to obtain in practice, and I want to point out that this chart is not a factual chart, but only shows trends, and is only intended to demonstrate the fact that there is a proper time to make replacement.

I think the chart brings out one point in particular, that is that the rate of progress of automation is going to be governed by the investment that industry has in its present facilities. You cannot just disregard, or throw away new machines unless you have recovered your investment, and as you know, as automation grows, the investment in machines gets larger and larger, and it has a tendency to, because of the larger and larger investment, I think it has a tendency to level out change and keep change from being too sudden.

Now, I would like to give a couple of examples here of how automation has expanded markets. Automation, we all know, reduces costs. That is what it is intended to do. That is what we aim for when we create a machine. By reducing costs it expands markets and increases employment.

I have taken a story out of the Reader's Digest, the May issue, which I think illustrates this point very aptly. I would like to read it. It is very short. The storys says this:

> Only 5 years ago, the company—

referring to Corning Glass—

> was selling 20-inch TV blanks for $75 and losing money on each one. It wanted to create a demand for these tubes and believed its engineers could devise machinery to cut costs sharply. At that time no one had been able to handle more than a 4-pound gob of molten glass. Now, there is an 8-headed machine that takes a 15-pound gob in each of its craniums and whirls it until it becomes the funnel of a picture tube.
>
> So Corning is selling 21-inch blanks for $8.50 instead of $75 and making money on them, and 2,000 people have jobs that didn't exist before.

That is a case where automation expanded a market, reduced the cost of the product, and created many new jobs.

In the last 25 years we have seen oil and gas gradually replace the use of coal. The change has been a gradual one, and the hardship has been, I would say, not great. The number of workers employed in the coal mines has declined substantially over this period of years, while production has remained substantially the same. I think it is well to realize that mechanization or automation of the mine has made coal more competitive with oil and gas, and has probably saved thousands of jobs from annihilation.

I would like to now say a few words about the hardship that occurs from technological change. I have read much of the testimony that has been presented to this committee, and I think most everyone agrees that the long-range effects of automation are good. In the long run automation raises our standard of living, it makes our jobs easier, and safer. There seems to be a difference of opinion, however, about the immediate effects of automation. It is argued that automated machines create temporary hardships for some workers. Over a period of years I have witnessed the installation of thousands of automated machines, and during this time I have never seen where the installation of a new machine has caused workers to be laid off or discharged. I don't know of any company that does not retrain its workers to new jobs when changes are required by a new product or a new process.

Voluntary quits in industry eliminate the possibility for hardship from technological change. According to the Department of Commerce Survey of Current Business, discharges and voluntary quits in manufacturing establishments vary from 1¼ to 1¾ percent per month, or from 15 to 22 percent per year. This rate of return exceeds by a wide margin any normal productivity increases, or any anticipated productivity increases. Thus I think we conclude that any normal separations eliminate the need for all layoffs that might result from productivity increases.

The only exception could be the very smallest employers, those that normally employ only a handful of workers, and that have practically no diversion. I think you will find in our large companies where they have a diversity of product, that the workers are absorbed as changes are made.

Now, as I look ahead to the future I see one element that disturbs me considerably, and that is European competition. A year ago last spring I was sent over to Europe, as a part of a negotiating team to negotiate an embargo list of machine tools; a list of machine tools that would be embargoed for shipment behind the Iron Curtain. I was acting for the Department of Commerce.

In these negotiations we sat down with 14 other free nations to discuss what machines should be strategic; what machines should not be traded to Iron Curtain countries, and I learned a little bit about how these foreign governments operate and maneuver trade between themselves. I don't believe that we in the United States understand thoroughly how much maneuvering actually goes on between these governments, so one government can get a trade advantage over another.

I almost came away with the conclusion that the whole matter of embargoing goods to the Iron Curtain countries was devised for the purpose of maneuvering trade positions. The wages and prices in these countries are controlled. They are controlled very rigidly. The labor rates in most of these European countries will range from 50 to 75 cents an hour, whereas in the United States the same type of labor will cost from $2 to $2.50 an hour.

Their straight-time workweek may be 48 or 60 hours a week, whereas ours is 40 hours a week.

Today automation is growing very rapidly in Europe. The productivity of the European worker is increasing a great deal. I know of one company—this company makes printing presses—that has discontinued making printing presses in this country and has laid off its workers because they cannot compete with foreign European-made printing presses. The differentials in labor rates are just too great.

We don't have difficulty competing with these foreign producers except on products that have a high labor content. That is the situation at the present time, but I think as automation increases in Europe, and it is increasing rapidly, that situation is going to change, and we are going to get more severe competition in the products that do not have a high labor content.

When I was in Europe I had occasion to visit a number of foreign plants. I looked at their machinery, and I saw what was happening. I saw where from 1950 up until a year ago they had changed from what I would consider to be 1920 technology to 1950 technology. In other words, they had covered a span of about 30 years in a period of 3. Many of these plants are highly automated at the present time, and the productivity of the workers is increasing, and the labor rates are controlled by the Government, if not directly, indirectly, and so are prices. They are going to be in a very favorable position to capture some of our American markets, and they want to capture our American markets.

The one way that we have been able to compete with these countries with the wage differentials that we have today is with our superior productivity. I believe that anything that we do to increase costs, that is, prices and labor, without increasing productivity is only going to aggravate the situation.

You have heard, I am sure, that our labor force is not going to increase as rapidly in the next 15 years as our population. It would be a very easy thing for this country, in my opinion, to fulfill that gap with foreign goods. In other words, if we don't bring our productivity up to take care of our needs with the relatively smaller work force, the gap could be filled and probably will be filled by foreign goods. Once these Europeans have captured our markets, I think we will have a difficult time getting them back, very difficult, because the only way we will get them back, I believe, is to make a very substantial adjustment in our labor rates and our prices. I don't think we will ever get any protection out of tariffs, because I think that these fellows are just too good at maneuvering themselves into a favorable trade position, regardless of the tariff situation.

I saw enough of that over there so that I am convinced in my own mind, at least, that they are masters of the art of maneuvering things, to gain trade advantages. It would take us years to get the experience they now have. So I think it is almost a first requisite for us to maintain an increase in productivity, and I think we can do it. I think Government should do everything that it can to discourage obsolescence in our factories. I think business has a definite obligation to keep obsolescence to a minimum, to modernize and replace as often as it is economically feasible to do so. As I tried to point out with the chart (fig. 6) there is a point when it is economically desirable to replace, to modernize, if you want to call it that. I think business has a very definite obligation in that respect.

I think, too, that the Government can help, particularly with the tax regulations on depreciation. Depreciation allowances have not been adequate to take care of industry's replacement needs. If it hadn't been for rapid tax amortization during World War II, and again during Korea, I don't believe that we would have this high level of prosperity that we have today. I think our plants would be obsolete. We wouldn't be where we are today except for the fact that that rapid tax amortization pumped the funds into industry to modernize and bring it up to the level that it is today, and it isn't too high today.

One thing I feel very strongly about is this: Our depreciation allowances are based on survival curves and estimated lives of machinery, and today machinery becomes obsolete long before it wears out, and we have no way of dealing with this problem of obsolescence.

The other thing that has hurt industry is inflation. All of our reserves today are based on the machines that we bought a long time ago. That means we probably can only buy half as much with our reserves as we should buy to stay up to date. In other words, we cannot go out and replace machines today on 1945, 1946, or 1947 prices, but still our reserve allowances are based on those prices, and that is what we are getting out of our reserves for replacement purposes.

So I believe the Government should assist industry in keeping obsolescence to a minimum with better depreciation regulations.

I would like to go back and say again, I think that the foreign situation is one that could seriously affect us, and I would like to repeat once more that any increase in prices, any increase in labor rates, that are not offset by productivity increases, are suicidal, in my opinion.

The CHAIRMAN. Mr. Ensley would like to ask some questions.

Mr. ENSLEY. Mr. Cross, I am very interested in your report on the rapid technological development in western Europe.

Mr. CROSS. Yes.

Mr. ENSLEY. Just so that we don't misunderstand you, you don't in any way begrudge that remarkable development and recovery of recent years in Western Europe, do you?

Mr. CROSS. No; I do not.

Mr. ENSLEY. Your fear is that it might put us in a competitive position in some respects and squeeze some of our producers here; is that your fear?

Mr. CROSS. Yes; I feel that is true, and I feel the Europeans could capture some of our markets, and I think we have forgotten that the balance of trade could go against us.

Mr. ENSLEY. You mentioned that during the next decade when we may have relatively labor shortage we might find ourselves increasing tremendously our imports from Western Europe; is that right?

Mr. CROSS. I think that could happen, yes.

Mr. ENSLEY. How would you visualize that we would pay for those imports?

Mr. CROSS. From our gold reserves, as long as we had them.

Mr. ENSLEY. These reserves wouldn't last very long, though, if there was a predominant drift the other way. Wouldn't it boil down really to the fact that we would have to start shipping them goods in return?

Mr. CROSS. We would have to if we were going to maintain our position, but that is my point. I think that we might lose our position, and if the pressure is there for the goods and we have the reserves with which to buy them, the pressures from the people might be such that they would be willing to spend that money to maintain our standard of living.

Mr. ENSLEY. You mean export gold reserves?

Mr. CROSS. Export the gold and that would bring the goods in. Of course, it couldn't go on forever, because we would run out, but by that time we would be in a very unfortunate position.

Mr. ENSLEY. Well, I am not quite as pessimistic with respect to our ability to compete with foreign producers. I am rather disturbed to find that you feel there is danger for our whole economy in competition from Western Europe.

Mr. CROSS. I don't think there is danger in our whole economy at the present time. At the present time, the competition is mostly in the heavy-goods industry; that is, industry where you have a high labor content in the product, and I think that brings out another point that is extremely important: Those are our basic industries and the industries that we rely on for our national defense.

You take your power-generating-equipment industry. It is under very severe competition from European producers at the present time. As a matter of fact, some of the installations that have been purchased by the Government recently have been purchased abroad, because they could be purchased cheaper. There is a good deal of competition in the machine-tool industry from abroad.

Those are two industries that I can think of that are very basic and essential to our national defense.

Mr. ENSLEY. Do you think our ability to manufacture those machines is or could be jeopardized by the importation of a few generators or machine tools from England or Western Europe?

Mr. CROSS. I don't think it is a question of just a few. I think you will see that it grows.

Mr. ENSLEY. Could you put in the record the amount of imports of those particular machines?

Mr. CROSS. In power-generating-equipment industry, I could not, and I can't even give you exact figures on machine tools, but I know that the rate of importation now in machine tools is several times higher what it was prior to 1950.

Mr. ENSLEY. But still a very small fraction of our domestic production?

Mr. CROSS. That is true, but it isn't what it is today, because we do have a good situation. There is no question about that. It is the possibility that if we don't continue to improve our productivity, that these things can change.

Mr. ENSLEY. Your basic point is absolutely correct and clear; that there is necessity for ever-increasing productivity. That, I gather, is your main point. There is no disagreement on that.

Mr. CROSS. That is right. I believe also, if we are going to continue to increase our productivity, we have got to give a little greater consideration, particularly in depreciation allowances, to the factor of obsolescence, because today we don't have the same situation with this type of machine that we had even 10 years ago. We create a machine to do a certain kind of a job, and even though we are trying to make those machines more flexible all the time, if the product changes, a substantial part of that investment changes, and they become obsolete before they wear out.

Mr. CROSS. So it is necessary.

Mr. ENSLEY. Thank you very much.

The CHAIRMAN. Mr. Cross, I know we have been greatly helped by your testimony. We are indebted to you for giving us the benefit of your knowledge and experience. We know that this thing we call automation will require a continuing study.

We are expecting to come up with some recommendations in the near future, but we are going to study the question continually.

Mr. CROSS. Thank you, sir.

The CHAIRMAN. And anything that you are going to place in the record in connection with your testimony you certainly have the privilege of doing so.

(The prepared testimony of Ralph E. Cross is as follows:)

TESTIMONY ON AUTOMATION BY RALPH E. CROSS, EXECUTIVE VICE PRESIDENT OF THE CROSS CO., BEFORE THE SUBCOMMITTEE ON ECONOMIC STABILIZATION OF THE JOINT COMMITTEE ON THE ECONOMIC REPORT, OCTOBER 26, 1955

My name is Ralph E. Cross and I am executive vice president of the Cross Co., of Detroit, Mich. My company designs, manufactures, installs, and services automated machine tools. In my day-to-day duties I have the responsibility for sales, engineering, service, advertising, and public relations. I have been in the business of making automated machine tools for 23 years.

DEFINITION OF AUTOMATION

Automation is the application of cost-reducing machines and techniques. This definition is a broad one, but it is the only one that takes in all of the popular concepts of the word.

The motivating forces for the application of automation are (1) higher wages, (2) lower prices, (3) higher profits, (4) improved product quality, and (5) greater safety.

Automation has been in the metalworking industries for over 100 years.

AUTOMATION HAS BEEN OVERGLAMOURIZED

The glamour that has been attached to the word "automation" has stimulated our business and, as a result, I do not like to say anything that would detract from the romance. Nevertheless, in the interest of sanity, I think automation should be debunked to some extent.

In descriptions of automated machinery I have seen the word "robot" used hundreds of times, and yet I have never seen a robot, nor do I know any engineer that is trying to create one.

There have been many attempts to compare the capabilities of a machine with the capabilities of a human being. We have all read about giant brains, machines that think and machines that have the capacity to reason, and we have been told that machines are capable of doing anything that a man can do and do it better. I would like to say that these descriptions are grossly exaggerated. There never has been a machine that does not depend on man in one way or another, and I doubt if there ever will be.

Most of the fantastic predictions about the future of automation are the products of some dreamer's imagination. I am positive these stories do not come from the people who create the machines or from the people that have the responsibility of making them perform on the production line.

From a report in the New York Post, we find this quotation from Stanley Tylak, a Ford worker who was shifted from River Rouge foundry machine shop to the new automated engine plant. Stanley Tylak said:

"The machine had about 80 drills and 22 blocks going through. You had to watch all the time. Every few minutes you had to watch to see everything was all right. And the machines had so many lights and switches—about 90 lights. It sure is hard on your mind."

"If there's a break in the machine the whole line breaks down. But sometimes you make a little mistake, and it's no good for you, no good for the foreman, no good for the company, no good for the union."

Now if these machines are operated by giant brains, if magnetic tapes and punched cards give them their directions, if they are self-adjusting and self-correcting, and if they run all day long without ever making a mistake, what in heaven's name was wrong with Stanley Tylak. There wasn't anything wrong with Stanley Tylak. Automated machines do not function as you have been led to believe they do and, as a matter of fact, I don't think they ever will. The human being or the Stanley Tylaks are the most important elements of our modern automated plants.

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I think there will be a better understanding of automation if we look at a few examples.

SECTIONIZED AUTOMATION

The sectionized transfer-matic shown in figure 1 machines V–8 engine cylinder block castings at the rate of 100 pieces per hour at 100 percent efficiency. It, of course, does not operate at 100 percent efficiency because this would mean that it runs continuously without stopping. Overall it is 350 feet long and performs 555 operations on each part it machines. It is operated by a crew of 3 men, comprising 1 direct labor operator and 2 setup men. It was put into operation in the summer of 1954, and it is the first sectionized transfer machine ever made. It is divided into five sections to improve its operating efficiency by minimizing the time lost for changing tools and minor repairs. Anyone of the sections can be stopped while the other sections continue to produce at their normal rate.

The tool-changing programs are governed by 7 machine-control units similar to the unit shown in figure 2. For every tool in the machine there is a toolometer, figure 3, on 1 of the machine-control units. These toolometers count the operations performed by the tools, and when the prescribed program for a tool expires, the toolometers stop the tool from further operation by stopping one of the machine sections. Parts being produced by the preceding section are stored at the entrance of the stopped section. At the same time, conditioned parts are fed into the next succeeding section. After the setup man replaces the dull tool, he resets the toolometer and the stopped section returns to normal operation.

Sectionized automation minimizes the accumulation of lost time for predictable maintenance and thereby maintains operating efficiency when large numbers of operations are combined.

The toolometer is basically a memory unit to tell the tool setters when to change tools. It would be impossible, for example, for any man to keep a mental account of all tools in this transfer-matic.

Sectionized automation is used for the mass production of complex parts. It would not be profitable to use sectionized automation on parts of simple design, or for job-lot production.

A TRANSFER-MATIC FOR TRACTOR REAR AXLE HOUSINGS

The transfer-matic shown in figure 4 machines tractor rear axle housings at the rate of 46 pieces per hour at 100 percent efficiency. Castings come to the machine from the foundry—and as they leave the last section they are ready for assembly. The installation is 225 feet long, and it performs 313 operations. It utilizes five direct labor operators per shift.

The machine could be operated by a crew of 2 workers, 1 direct labor operator and 1 setup man by applying automation handling equipment between the sections. Investment in this additional equipment would increase the cost of the housings, even though it would reduce the labor cost—consequently it was not designed into the machine.

TRANSFER-MATIC FOR ASSEMBLING V-8 ENGINES

The transfer-matic shown in figure 5 is used to assemble the new 1956 Plymouth qualimatic V–8 engines. It is installed in the newest, automated engine plant in the automobile industry.

The installation consists of an engine assembly transfer-matic, 560 feet long, and 2 cylinder head assembly transfer-matics, each of which is 126 feet long. All are coordinated and timed to produce 150 finished engines per hour. Assembly starts at three different points with the cylinder block and cylinder head castings. These three major castings are automatically transferred through 198 stations where other parts and subassemblies are added, some automatically, some manually. In the end they all come together to make the completed engine.

HOW AN AUTOMATED MACHINE IS BORN

The story of how an automated machine is sold and made provides a good view of the practical economic factors that influence the specifications for such a machine. I would, therefore, like to tell you the story of the transfer-matic for assembling V–8 engines shown in figure 5.

The story begins back in October 1954. During one of his visits to the Plymouth plant, our sales engineer received an inquiry for a machine to assemble the new Plymouth engine. From time to time members of the industry had discussed the idea of assembling an automobile engine by machine, but no one had ever given the idea real serious consideration. We were naturally enthused with the inquiry and that same afternoon I visited the Plymouth plant accompanied by our sales engineer and our chief engineer and sat down with the Plymouth master mechanic and his staff to discuss the feasibility of making this machine. This first meeting collected the ideas of the group and outlined, in a broad way, the objectives.

The next day a Cross proposal engineer, working cooperatively with the sales engineer, the chief engineer and myself, began the work of conceiving the machine. Henceforth, the inquiry was known as Cross project 8455. Within a week the proposal engineer had our ideas converted into proposal drawings. These drawings were shown to Plymouth at a second conference, and suggestions were developed for furthering the project. As fast as time would permit, we visited other engine plants, notably Chrysler, General Motors, and Ford, studying existing assembly methods. Many additional engineering conferences were held, and many additional proposal drawings were made in the weeks that followed.

By the end of November we had devised a machine, which appeared to be salable. We then estimated the price and submitted a proposal to Plymouth on November 26, 1954. As soon as Plymouth received our proposal, they estimated the total cost of assembling the engine with the proposed equipment, and compared this cost with alternate assembly methods to determine the best investment. Eventually, we submitted prices for the mechanisms at every station so that Plymouth could evaluate each unit individually. Because of the cost, many of the mechanisms that we proposed for mechanical assembly were rejected in favor of manual labor. An example is the automatic unit to assemble the crankshaft, flywheel, and clutch assembly shown at station 14, figure 5. After a thorough review of every assembly unit by the Plymouth engineers we eliminated the uneconomical units from the machine and submitted a final proposal. This machine was the best that could be devised and Plymouth engineers estimated that it would assemble the new Qualitmatic engine at the lowest possible cost. On December 1, 1954, we obtained Plymouth's purchase order for the equipment.

The next day, project 8455 was assigned to a project engineer, and the job of designing the machine began. The project engineer, working with designers and draftsmen and in cooperation with the sales engineer and Plymouth engineers, made the engineering drawings for the machine. On March 19, 1955, the engineering department released the bill of material and complete specifications for satisfying the requirements of the order.

Th job of manufacturing the machine then began. Patterns, castings, weldments, bearings, hydraulics, and electrical equipment were all purchased and scheduled for delivery into our plant. Skilled machine operators performed thousands of precision machining operations, such as boring, grinding, milling, turning, and drilling to prepare the parts for assembly. On the assembly floor the parts were put together by tool builders, electricians, and hydraulic men. At the completion of the assembly, the machine was put through a series of running tests, and it was then shipped to the Plymouth plant.

At this point responsibility for project 8455 was transferred to our service department. Demonstrators were sent to the Plymouth plant to supervise the installation of the machine and to instruct Plymouth personnel on operation and maintenance. One day in late July the installation was complete. The first Qualitmatic engine came out of the end of the machine, and another automated transfermatic was born.

BALANCING MECHANIZATION WITH MANUAL LABOR

The purpose of automation is to lower costs; not eliminate or save labor. We have conception drawings in our engineering department of many machines that will reduce labor costs and, much to our disappointment, our customers are not in the slightest bit interested. The difficulty with these machines is that they simply do not reduce production costs; the mechanization cost is too high.

The secret of low-cost operation is getting the proper balance between mechanization and labor. Every time a new machine is purchased a decision is made between more mechanization and less labor on the one hand—or less mechanization and more labor on the other. For example, you will remember that in selling the engine assembly transfermatic, we submitted separate prices for each of the individual assembly mechanisms. Plymouth used these prices to balance mechanization and labor for the lowest possible assembly cost. Many of the proposed mechanical units were rejected in favor of manual labor. In all my years of experience creating automated machines I have never sold a machine that I could not have made more automatic. All mechanization and no labor never provides the lowest operating cost.

THE RATE OF PROGRESS IS CONTROLLED

In every manufacturing operation, there is an economic point at which time it becomes profitable to replace an old product, or process, with a new one. Good timing is extremely important because losses occur from premature replacement as well as delayed replacement. The importance of good timing is graphically illustrated in figure 6. Curve A plots the profits of a process from the year of installation to the time it is no longer profitable. The decline is the result of obsolescence. Line B plots the profits per unit that might be expected from installing the most up-to-date process conceivable at the beginning of each year. The increase in profits is the result of technological progress. The question immediately arises as to why B does not create as large a profit as A in the early years. The reason is that B must absorb the loss that would result from selling the equipment in process A before its investment is fully amortized. Lost profits resulting from premature or delayed replacement are represented by the difference between A and B. The best year for replacement is where the lines cross.

The chart shows that replacement will not be governed solely by technological progress. The unamortized stock of facilities in existence keeps the growth of automation in bounds in the same way that the governor keeps a steam engine from running away from itself.

AUTOMATION EXPANDS MARKETS

Automation reduces cost and, thereby, expands markets and increases employment. From the story What's Behind This Word "Automation," which appeared in the May issue of Reader's Digest, I have taken this quotation:

"Only 5 years ago, the company [Corning Glass] was selling 20-inch TV blanks for $75 and losing money on each one. It wanted to create a demand for these tubes and believed its engineers could devise machinery to cut costs sharply. At that time no one had been able to handle more than a 4-pound gob of molten glass. Now there is an 8-headed machine that takes a 15-pound gob in each of its craniums and whirls it until it becomes the funnel of a picture tube. So Corning is selling 21-inch blanks for $8.50 instead of $75 and making money of them, and 2,000 people have jobs that didn't exist before."

In the last 25 years we have seen oil and gas gradually replace the use of coal. The change has been gradual and generally the hardship has not been great. The number of workers employed in the coal mines has declined substantially while production remained practically constant over a period of years. I think it is well for the committee to realize that mechanization or automation of the mines has made coal more competitive with oil and gas, and has probably saved thousands of miners' jobs from annihilation.

TECHNOLOGICAL CHANGE DOES NOT CREATE HARDSHIP

Everyone agrees that the long-range effects of automation are a good thing. In the long run, automation raises our standard of living, makes jobs easier and safer. There is a difference of opinion, however, about the immediate effects of automation. It is argued that automated machines create temporary hardships for some workers. Over a period of years I have witnessed the installation of thousands of automated machines and during this time I have never seen where the installation of a new machine has caused workers to be laid off or discharged. I don't know of any company that does not retrain its workers to new jobs when changes are required by new products or new processes.

Voluntary quits in industry eliminate the possibility of hardship from technological change. According to the Department of Commerce's Survey of Current Business, discharges and voluntary quits in the manufacturing establishments vary from 1¼ to 1¾ percent per month, or from 15 to 22 percent a year. This rate of turnover exceeds by a wide margin any and all productivity increases, or any anticipated productivity increases. Thus normal separations eliminate the need for all layoffs that might result from productivity increases. The only exception could be the very smallest employers, those that normally employ only a handful of workers.

FOREIGN COMPETITION MUST BE WATCHED

Most of us assume that automation is something that belongs to America. Americans have no monopoly on automation; it is growing rapidly in other parts of the world, and particularly in Europe. The productivity of the European worker is growing rapidly. It is time we ask ourselves how the American worker is going to compete with the European in the years to come.

When I was in Europe in 1954 I visited some of the automobile plants and talked with many of the engineering firms that make their machines. I saw automation being applied in every auto factory. In some instances European plants are more advanced than our own.

Sometime during the past 5 years Europeans have come to realize that the key to thir future lies in increased worker productivity. They have already had a taste of the benefits of automation and they are hungry for more. This new European viewpoint is a good thing, and I think in the long run the world will benefit, but we in the United States must remember that wages, prices, and markets in most European countries are controlled either directly or indirectly. European wages are 50 to 75 cents per hour as compared to $2 to $2.50 per hour in the United States for the same kind of labor. In my own mind, I am convinced that European wages are going to be kept at this low level or very close to it. This means that the Europeans will have a tremendous competitive advantage over us if they continue to improve their productivity. By applying automation they see an opportunity to capture a larger share of the United States market. They are already enjoying some success with products that have a high labor content. One company has discontinued manufacturing printing presses in the United States and is now the sales agent for a European manufacturer. Some companies are building plants in Europe to maintain their share of the European market, but I am convinced that they are also looking forward to the time when competition may force them to supply the American market from their European plants.

If the situation gets serious, higher tariffs will help very little. Tariff rates could not be changed in time to avoid hardship, and in addition, European countries would probably retaliate and further aggravate the situation.

Estimates show that the American work force will not increase as fast as the population increases in the next 15 years, and we must, therefore, increase our productivity to maintain our present standard of living. If American productivity does not increase during this period, it is quite possible that the void may be filled with goods and services supplied by Europeans. If Europeans do get a hand on our markets, I think we will have a hard time getting them back. Some people will argue that we can ship more goods abroad if our import trade increases; this is not necessarily true. American prices are much too high for the purchasing power (controlled wages) of the European consumer.

As I see it, the United States has but one course open to it. It must continue to improve its productivity and it must not look for additional social gains, such as the shorter workweek, or higher wages, unless they are definitely earned by productivity increases.

OBSOLESCENCE MUST BE ELIMINATED

America can continue to expand its economy and maintain its high level of employment by destroying obsolescence. A high rate of change is essential. American industry must continue to grow and, at the same time, it must modernize and replace its plants and equipment as fast as it is economically feasible to do so.

When a company ceases to modernize its products and replace its machinery and equipment, it quickly degenerates into a state of obsolescence. The workers in such companies are usually subjected to frequent layoff periods and more often than not, they eventually lose their jobs altogether. In contrast, the companies that keep their machinery and equipment up to date are on a sounder footing and, as a result, they offer their employees better wages, better working conditions, and more continuous employment.

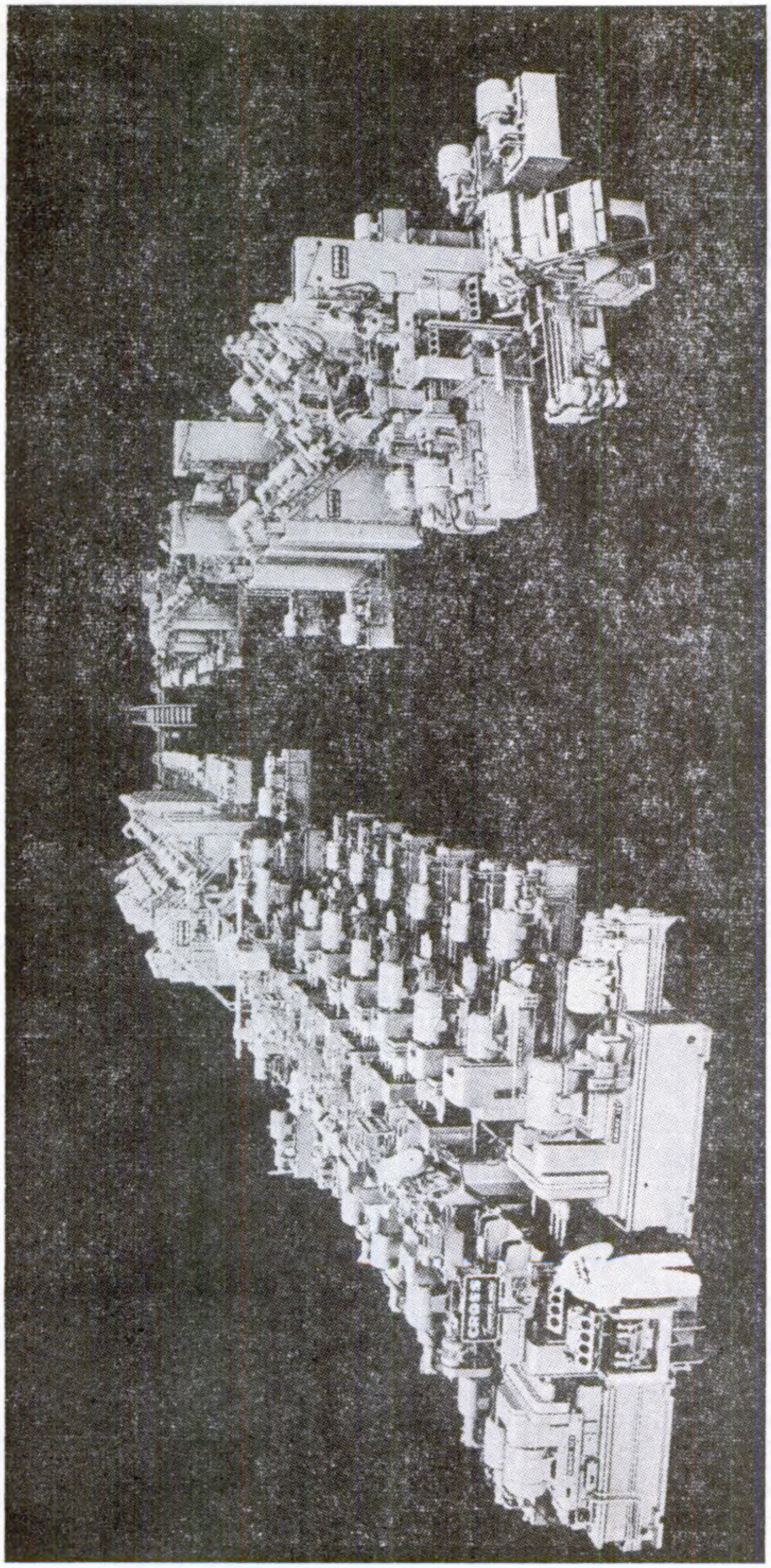


Figure I

CROSS TRANSFERMATIC
For Machining V-8 Engine Blocks

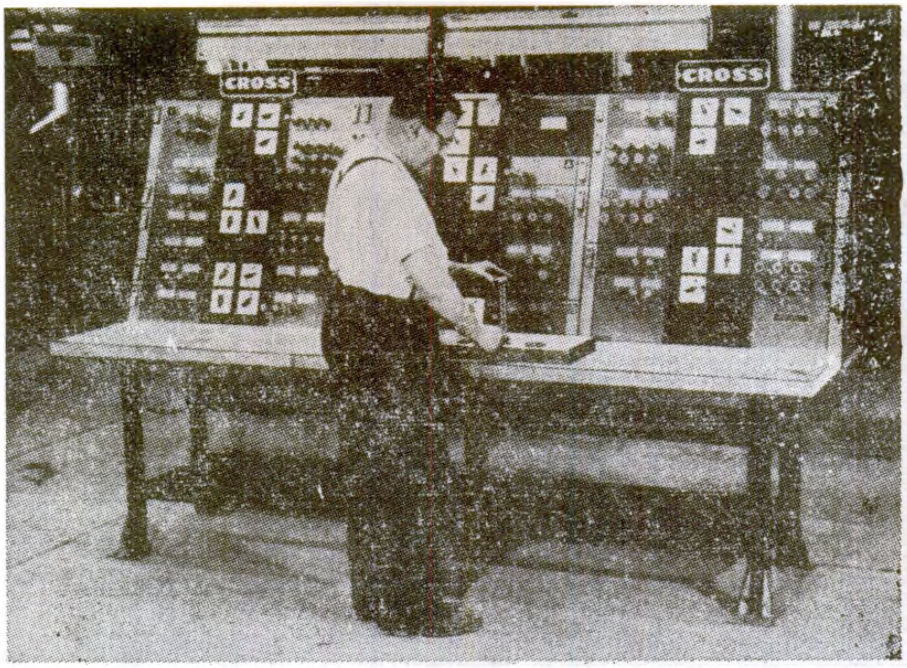


Figure II

Machine Control Unit

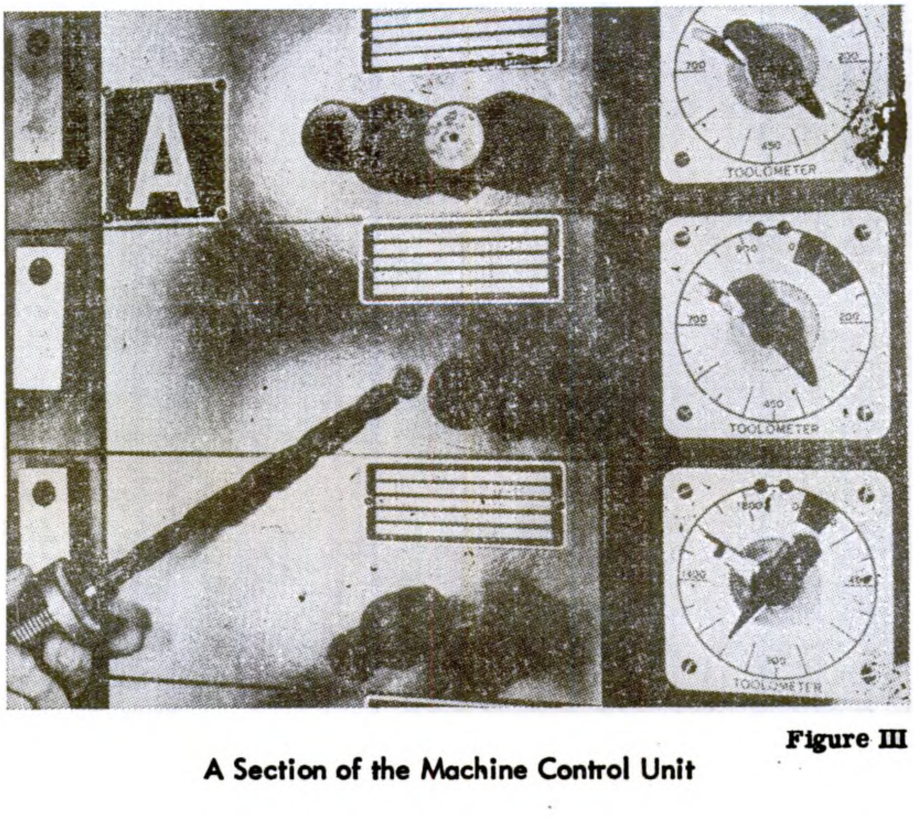
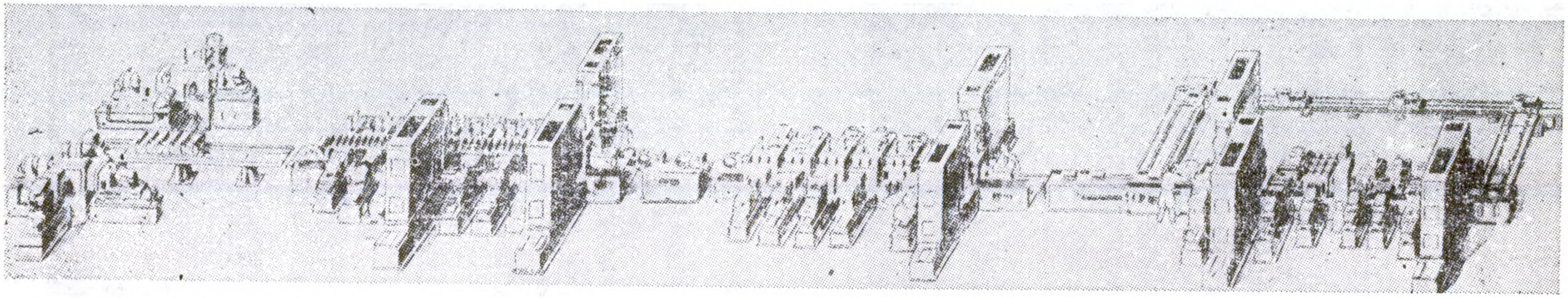


Figure III

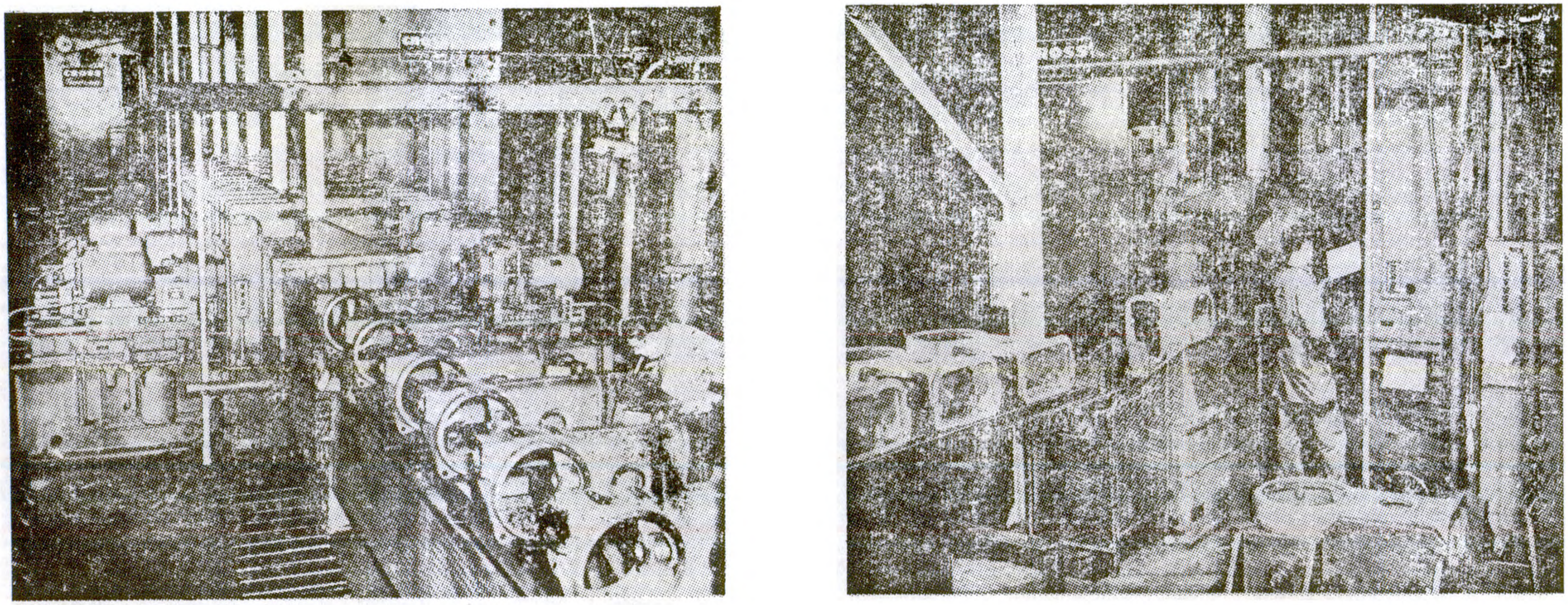
A Section of the Machine Control Unit

CROSS TRANSFERMATIC

For Machining Tractor Rear Axle Housing



225 Feet Long - 4 Sections

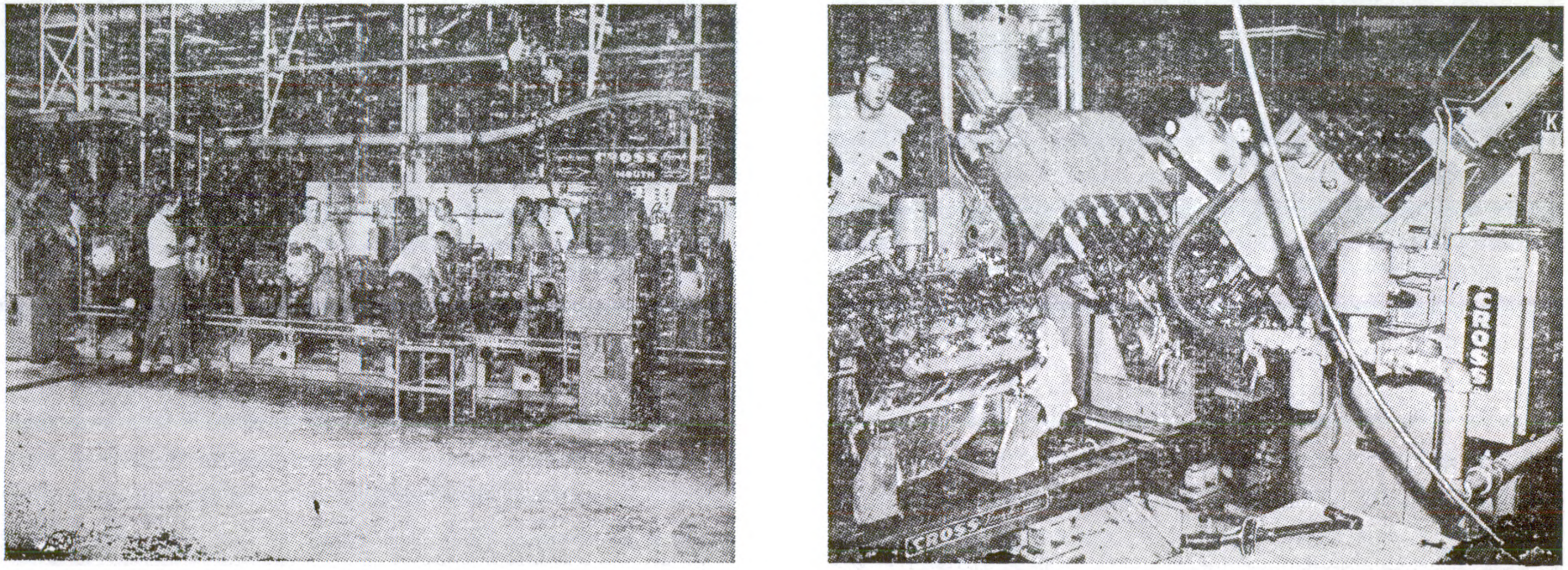


Tractor rear axle housing leaving Section 3

Tractor rear axle housing going into Section 2

Figure IV

CROSS TRANSFERMATIC
For Assembling V-8 Engines
560 Feet Long - 3 Sections



Automated units position the crankshaft and tighten the connecting rod bolts. The pistons and the connecting rods are inserted in the cylinder by the workmen in the foreground.

Close-up of automated unit for tightening the cylinder head bolts.

Figure V

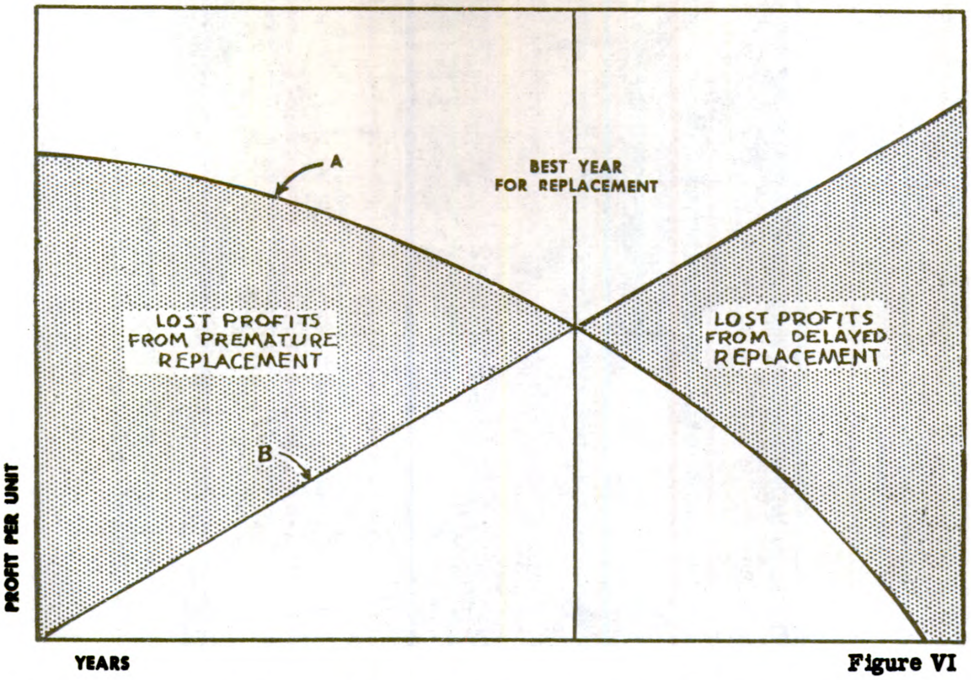


Figure VI

Part of the fault for obsolescence lies with the Government. For the past 20 years the Treasury Department has been stifling business with unreasonable depreciation regulations. Depreciation reserve allowances are much too low to take care of industry's replacement needs. The new tax law passed by the 84th Congress helped the situation somewhat, by allowing faster write-offs in the early years of a machine's useful life, but today, machines become obsolete before they wear out. Depreciation allowances based on the wear-out life of a machine are not adequate.

We would not have the high level of employment we have today except for the rapid tax amortization funds that were pumped into industry during World War II and Korea for modernization and replacement. If we are to continue to prosper and grow, Congress must provide tax regulations that will permit industry to deal with obsolescence.

SUMMARY

Automation is not new.

There is no reason why workers should fear automation; industry is trying to reduce costs, not eliminate labor.

Automated machines are going to improve productivity slowly and, at the same time, they will make jobs safer and more respectable.

Automation is creating new jobs by lowering prices, and industry is retraining its workers.

Wage and price differentials between the United States and Europe must eventually be reduced; in the meantime, social gains must be earned by increasing productivity.

Government must help industry fight obsolescence.

Automation is a blessing, and may be our best form of security.

The CHAIRMAN. Before we close, we have some distinguished visitors here. I will ask the clerk to announce their presence.

Mr. LEHMAN. Thank you, Mr. Chairman. I am sure they listened with a great deal of interest to this last discussion. We have with us some members of a Norwegian team of economists who are visiting this country. We have Mr. Holler, an economist, wage and labor specialist, in charge of the office of economics of the Norwegian Federation of Trade Unions; we have Mr. Moe, who is an expert on price matters, a lawyer, and chief of the section in the Ministry of Finance;

and Mr. Larsen, who is a specialist in fiscal and tax problems, and economist in the Ministry of Finance.

They are accompanied by Mr. Lloyd Webb, of our State Department.

The CHAIRMAN. Thank you, sir.

Thank you very much, Mr. Cross.

The CHAIRMAN. If there is no objection, the committee will stand in recess until 10 o'clock tomorrow morning.

(Whereupon, at 4 p. m., the subcommittee recessed to reconvene Thursday, October 27, 1955, at 10 a. m.)

AUTOMATION AND TECHNOLOGICAL CHANGE

THURSDAY, OCTOBER 27, 1955

Congress of the United States
Subcommittee on Economic Stabilization of the
Joint Committee on the Economic Report
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Wright Patman, chairman, presiding.

Present: Representative Wright Patman, chairman of the committee, presiding. Also present: Staff Economist William H. Moore and Staff Director Grover W. Ensley.

The Chairman. The subcommittee will please come to order.

We have as our witness first this morning Mr. Clifton W. Phalen. When we decided the communications industry was one of these in which technological advance had been so rapid, that we ought to make special inquiry, we scarcely knew where to turn to find the best equipped single representative who might discuss this industry with us.

In the Bell System you have the American Telephone & Telegraph Co. at the top, and then there are also the Bell Laboratories and Western Electric, the manufacturing company, to say nothing of the regional companies. Since all of these might have an interest in the field, we asked the system to select for us the person who could cover all of these phases most adequately.

After canvassing the field, they tell us that you have filled many responsible positions in the system, Mr. Phalen, during your 27 years of service, and during this time you have been closely associated with all branches of the telephone industry. We are mighty glad to have you, Mr. Phalen, and you may proceed in your own way as you desire.

STATEMENT OF CLIFTON W. PHALEN, PRESIDENT, MICHIGAN BELL TELEPHONE CO., ACCOMPANIED BY HENRY CRAMPTON, ASSISTANT VICE PRESIDENT

Mr. Phalen. Thank you very much, Mr. Chairman. My name, as you know, is Clifton W. Phalen, and I am president of Michigan Bell Telephone Co. I would also like to introduce the gentleman at my right, Mr. Henry Crampton, who is an assistant vice president of our company.

I am appearing, as you said, on behalf of the Bell System, which includes American Telephone & Telegraph Co., its 20 telephone subsidiaries, the Bell Telephone Laboratories and Western Electric Co., our manufacturing and supply organization.

These companies employ more than 725,000 men and women, of whom more than 230,000 have worked in the system 10 years or more.

I wish to thank the subcommittee and the staff for the opportunity to appear here today. I hope that what I have to say will be helpful to the committee in its study of automation.

As the subcommittee pointed out last April in its release announcing its study, "automation" is a relatively new word. It is variously defined. To me it means general technological progress of the kind that has been taking place in our industry and in others for many years. It is in this broad sense that I would prefer to use the word.

Automation, however, apparently suggests to some people that factories and even some industries of the future will run automatically, with only a few persons needed to control operations.

I wish to emphasize at the very beginning of my remarks that nothing resembling this result is in prospect for the telephone industry. We see changes ahead, but not changes of a revolutionary nature. Although we use large quantities of automatic equipment, the dial telephone being a good example, we are convinced that our business will continue to be operated by very large numbers of employees.

Before entering into a detailed discussion of automation in the Bell System, I should like to stress several basic thoughts.

The first has to do with the reasons for automation in our companies. We have introduced dial equipment and many other scientific and technological improvements throughout the years for three basic reasons: to improve the quality and usefulness of telephone service, to satisfy the demand for service, and to keep the cost of our product at a reasonable level.

The result has been a marked expansion of telephone usage over the years. Telephones and telephone calls have increased many times more rapidly than population, and even more rapidly than gross national product. I will give the facts in detail later.

The increased telephone usage resulting from scientific and technological progress has, in turn, helped to expand employment. This will be clear by comparing the present-day situation with that in 1920, the year conversions of telephones to dial operation first began in the Bell System. At the present time about 85 percent of Bell System telephones are dial operated. Operators are now dialing directly nearly 60 percent of long-distance calls. Customers now dial directly about a quarter of all calls outside local areas. Yet employees number nearly three times as many as in 1920, when there were no dial telephones, and over twice as many as in 1940, when about 60 percent of telephones were dial.

In studying automation in the Bell System it should be borne in mind that we render an essential public utility service, subject to regulation as to operations and rates by public authorities. It follows that technical advances in the business and economies in operation are necessarily and properly shared in large measure with the public.

With these preliminary remarks I will go to a review of past technological developments in the Bell System. I will then discuss the effects they have produced, having in mind that the committee has indicated an interest in the distribution of gains from such developments among workers, investors, and consumers. Finally I will give our views as to possible future developments:

Past scientific and technological developments.

General:

Undoubtedly the most important technological change that has taken place in our business has been the change from manual to dial switching. This is the only development that I will discuss in any detail.

Although I will so limit my discussion, it is important to remember that dial switching equipment is just one component in what is really a single integrated plant, comprising a vast network of communication channels and related equipment.

Telephone service of present-day quality and scope is therefore dependent not only upon modern dial equipment but also upon improved transmitters and receivers, on improved cables, on the loading coil which reduces transmission losses, and on the telephone repeater which amplifies voice currents at intervals along the route. It is dependent upon apparatus which makes possible numerous telephone circuits on two pairs of wires, upon the modern coaxial cable—a small cable which can carry many hundreds of telephone calls simultaneously, on the radio relay with its beaming of long-distance telephone calls and television programs without the use of wires or cables, and on many other devices and techniques which have been developed and improved over the years for the carrying on of our business.

Developments in automation:

Now as to the development of dial switching.

Early in the telephone business the complex problem of connecting customers with each other was met by means of switchboards, where customer lines would terminate and where any two could be linked together. The early switchboards were all manually operated.

As the business grew, it became evident that manual operation would be less and less suited to handle the volumes of traffic being developed and foreseen for the future, to say nothing of permitting improvement in quality of service. After much investigation and experimentation, a dial system designed to meet our service requirements was introduced in 1920, permitting customer dialing of local telephone calls. Dial apparatus has undergone substantial change and improvement since then.

The first of the charts I have prepared for the committee, chart I, shows the increase in dial telephones in the Bell System. It reflects the gradual but steady progress made in installing dial equipment.

To me it seems to illustrate a very fundamental principle in our business, and that is that automation of various kinds is a very evolutionary and gradual process. You will notice that this has been taking place over a period of some 35 years.

Dial switching has been important to long-distance service as well as to local service. Technological developments now permit operator dialing of nearly 60 percent of all long-distance calls. For example, when a customer places a call with a Washington operator for a San Francisco number, the operator dials that number directly from her switchboard and the called telephone in San Francisco rings automatically in a matter of seconds. Customers' telephones in upward of 3,900 towns and cities can now be reached in this way.

Telephone users themselves are also dialing directly about one-quarter of the calls that go outside their local areas. While most of these calls are to neighboring localities, in the past few years we have seen the beginning of customer dialing of station-to-station long-distance calls. This service has already been introduced in certain suburban exchanges near cities which include New York, Washington, Baltimore, Pittsburgh, Detroit, Chicago, St. Louis, and San Francisco. Customers in those exchanges may now dial their own station-to-station calls to many distant points in addition to dialing short-haul calls to nearby localities.

Nationwide dialing of station-to-station long-distance calls requires a uniform numbering plan, a large network of dial-switching centers, and automatic equipment for registering certain information as to the calls. The automatic equipment, which also keeps a count of certain chargeable local calls, is the so-called AMA apparatus—automatic message accounting. It employs punched tapes which register the calling telephone, the called telephone, the time connection was established, and the time connection ended. A machine takes the information off the tape and assembles it for each customer.

The long-distance calls which will be customer dialed and serviced by the AMA apparatus are station-to-station calls not involving operator assistance. Operators will still be needed on other types of long-distance calls, including person-to-person calls. These other types of calls are the ones which require the longer periods of operator time.

Effects of scientific and technological progress:

Your committee has evidenced an interest in how the gains of automation have been shared among customers, employees, and investors. For our companies I will give data for each of these groups for today and for 1920, the year when dial mechanization of the Bell System began.

Effects on the users of service:

Let us first look at what has happened to our customers—the users of the service.

Quality and scope of service have improved:

Scientific and technological progress has improved the quality of service and has extended the scope and usefulness of service.

A few examples will illustrate the improvements in quality. Dial switching now provides a faster and more uniform service, with full-load carrying capacity available 24 hours a day. The speed and accuracy of the remaining operator-handled services have been improved through better apparatus and equipment. In the early 1920's the average time required to complete a long-distance call was about 10 minutes; now it's a little over a minute, with some calls which are dialed directly going through in as little as 15 seconds. Today more than 95 percent of the long-distance calls are handled while the customer remains on the telephone; in 1920 less than 10 percent were so handled.

In 1920 carrying on an average long-distance conversation was like conversing with a person in an open field at a distance of 80 feet; today the equivalent distance has been reduced to 10 feet. Subscribers' trouble reports—something wrong with the equipment which prevents satisfactory service—have been reduced 70 percent.

Technological progress has not only improved the quality of service, but has also increased the variety of the services we offer.

When you put these two things together, increase in quality and marked increase in variety, it spells one important thing, and that is increased usage.

As of today, there are more than 400 separate services available to our customers. Let me mention just a few by way of example: Telephone service for ships and automobiles, service to foreign countries, teletypewriter-exchange service, dial switchboards for individual customers, intercommunication systems and wiring plans, automatic answering devices, time and weather service, conference service, picture-transmission service, radio and television network service, speaker phones—those are the kind you use without taking the receiver off the hook—volume-control telephones, and school-to-home services for convalescing children.

Automation, therefore, has not only given the customer better service, but a wider and wider variety of services.

Cost of service has remained reasonable.

Now let us look at what has happened to the cost of services.

The Bureau of Labor Statistics started in 1935 to price the cost of local residence telephone service as a part of the so-called market basket of goods and services included in the Consumers Price Index. I call your attention to the second of the charts, chart 2. It shows the changes since 1935 in the cost of local residence telephone service and in the cost of all goods and services in the market basket. Telephone service is shown with Federal excise taxes excluded, as being a more accurate reflection of changes in the cost of the service itself.

This chart shows that while the cost of all goods and services was going up 95 percent, the cost of local telephone service rose less than one-third as much or 30 percent.

I believe, therefore, that the technological changes which the period since 1920 has brought have affected the customer in these ways: He has received constantly improving service, he has received a wider variety of services, and the cost of service has been kept at reasonable levels.

Result has been expanded usage.

The customers have reacted to this in a very natural but most significant way. Their usage of the service has increased tremendously. Progress and reasonable prices have stimulated demand. Let me illustrate this with a few charts.

Chart 3 shows the increase in telephones since 1920. Bell System telephones now number more than 45 million—more than 5 times as many as in 1920.

Chart 4 shows that more than 70 percent of American households now have telephones, as against less than half that percentage in 1920.

Chart 5 shows that the number of long-distance conversations has increased many fold since 1920.

Chart 6 compares the increase of telephones with the increase in population. It shows that the growth in telephones has been much more rapid.

Chart 7 compares the increase in telephones with the increase in gross national product. It shows that the growth in telephones has even exceeded the large increase in gross national product.

The charts we have just seen show a substantial increase in telephone usage. Technological progress has played an important part in this increase.

Just to summarize for a moment, at this point I would say that technological progress, by improving quality, by increasing the variety of the services, and by keeping the cost of the service at a reasonable level, has had a very marked effect on consumer demand and on the usage for our service.

Effect on employees: Now, with that background I think it is interesting to see how our employees have fared.

More usage has created more jobs, and the number of our employees is now at an all-time high. Before going into the details I would like to explain what the Bell System does to meet the problems of individual employees affected by automation. Since this is a phase of our business to which we give a great deal of attention. For example, here is what we do in connection with the introduction of dial systems:

My own company, like other Bell companies, has developed, over the 35 years that dial conversions have taken place, a guide for carrying out conversions. At the heart of all plans is the awareness that the company has a social responsibility to eliminate or alleviate adverse effects on its personnel.

In establishing the date for a conversion, the controlling consideration is to make that date sufficiently far in advance, generally about 3 years, to provide ample time for human as well as technical planning.

The conversion having been scheduled, the first step is to inform the employees. Usually, most of the employees on the payroll at that time can be given assurance of continued employment; this is partly because the force progressively reduces itself by resignations in the normal course and partly because of the opportunities for reassignments. During the preconversion period, all losses from the force are replaced, so far as possible, with people hired for temporary employment. These temporary employees are chiefly people who desire work for only limited periods, such as young women expecting to be married sooner or former employees who are willing to return to telephone work to help out for a short period of time. Regular employees who state their intention of resigning or taking an early service pension prior to the cutover date are urged to defer this action wherever possible until the dial conversion. These steps are all designed to reduce the number of potential displacements. Advance planning is also done to provide transfer opportunities for employees. These transfers may be to other types of work or to other offices in the same or other communities. Any retraining is done at the expense of the telephone company.

And I think this is a very important point: It is done at the expense of the telephone company.

I might say that in our business we do a very considerable amount of retraining in connection with automation and technological advancement, not only to operators but also to our skilled craftsmen, and craftsmen who become engineers, to our clerical people, and to others in our business. We have training programs of one kind or another that vary in length from a couple of weeks up to as much as a year; as I said before, all done at company expense.

In most cases, as a result of these measures, few, if any, regular employees must be laid off. The employees principally affected are telephone operators. The number of such layoffs is relatively small.

In the past 5 years there have been, on the average, less than a thousand a year throughout the system out of over a quarter of a million telephone operators employed. And usually those laid off have been offered transfers. To the individuals involved, however, the layoff can be a source of much difficulty. To meet such conditions, the Bell System companies for many years have had severance-pay plans under which employees who are laid off receive lump-sum payments varying in accordance with their length of service and wage rates.

An observation which I think will interest you was made some years ago about the Bell System treatment of employees in connection with dial conversions. When she was Secretary of Labor, Frances Perkins, wrote:

> Of the hundreds of occupations in which women are listed in the Census of Occupations, only about a dozen employ more women than do the telephone companies. The human problem of the displaced worker when the cutover was made from the manual to the dial system telephone exchanges is an almost perfect example of technological change made with a minimum of disaster. It was accomplished through human as well as technical planning. (People at Work, p. 209, published by John Day Co., Inc., 1934.)

With this background, I would like to take a broader look at the effect on the employee body of the conversions to dial switching.

The introduction of a dial system reduces the number of operators required for a given number of calls at a given location. It would be a mistake, however, to conclude that dial conversions have reduced the number of employees needed in the telephone business. To do so would be to ignore the important factor of growth in our business and to ignore the further fact that dial systems and other technological changes have been most important in producing growth.

Large numbers of telephone operators are still required with dial operation. When I use the phrase "telephone operators," I use it in a broad sense to include all women associated with the switchboard operation.

Many types of calls cannot be handled automatically, such as information calls, calls needing assistance, some calls from coin telephones, person-to-person calls, and reverse-charge calls.

Let us look at the facts. At the beginning of 1920, when there were no dial telephones, 115,000 persons were in the employ of the Bell System as telephone operators. At the end of 1954, 228,000 were employed as operators. At the end of August, 1955, 237,000 were so employed.

These figures are significant. However, the facts I will now give illustrate far better the overall situation with respect to employment.

I call your attention to chart 8.

Chart 8 shows how total employment in the Bell System telephone companies has increased since 1920. The facts are given for the American Telephone & Telegraph Co. as its telephone subsidiaries. The chart shows both peaks and valleys, but viewing the whole period the number of persons employed by Bell System telephone companies has increased almost three times since 1920. Since the beginning of 1955 employment in the companies has risen by about 33,000.

Chart 9 shows the rise in employment in the Bell System telephone companies relative to total civilian employment in the United States. We have been furnishing an increasing share of national employment.

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The Bell System's proportion of the total civilian employment is 76 percent higher now than in 1920.

Chart 10 shows that the payroll of the Bell System telephone companies has increased nearly 10 times—from $261 million in 1920 to $2,525 million in 1955. This reflects not only the increased number of employee but much higher wage rates.

Chart 11 compares average annual earnings of employees in the Bell System telephone companies with those of full-time employees in industry generally. It shows that earnings of Bell System employees have kept pace with those of workers in industry generally.

I would sum up the effect of technological improvement on our employees this way. It has brought increasing customer usage which, in turn, has created more jobs. And they are better jobs—jobs that pay much higher wages and jobs that compare favorably with those in other industries. Moreover, the real wages of telephone employees have increased appreciably and their purchasing power is at new high levels. This increased purchasing power benefits not only our people but is good for the economy as a whole.

Effects of developments on capital investment.

I will now discuss briefly how investors in the telephone business have fared.

It has been through the incorporation of improvements into plant that the savings of the telephone investors have been profitably employed and the integrity of the money invested in the business has been maintained.

Scientific and technological developments have also created a continuing need for further investment in the business. Chart 12 shows the growing investment in our plant, which is now more than 10 times what it was in 1920. In the 10 years since World War II we have added new capital at the rate of more than $800 million a year. This year we will add more than that.

Effect of technological progress on Nation as a whole.

Chart 13 shows the increasing number of share owners of American Telephone & Telegraph Co., now numbering close to 1,400,000.

I have commented on the effect of progress in the telephone art on three groups: customers, employees, and investors. I now wish to make some observations as to the benefits this progress has brought to the Nation as a whole. These general benefits are in addition to the increased purchasing power of our employees already mentioned.

The fast, accurate, and dependable telephone service now furnished in this country is vital to the common life of the Nation and to the national defense. Further, developments in the telephone art have made important contributions to such projects as the DEW line, the air-warning system across the Arctic. Telephone techniques have also led to better military equipment such as the weapons systems used for the automatic aiming and firing of guns, the control of bombs, and the control of guided missiles such as the Nike.

The Nation as a whole has also benefited from developments in the telephone field which have been of appreciable importance to products of other industries. Examples are motion pictures, hearing aids, radio, television, and automatic devices of many kinds.

Future outlook.

I will close by discussing some of the things that we see for the future.

Our present plans contemplate completion of the program for converting the remaining manual offices to dial. Five years from now more than 95 percent of our telephones will be dial operated. In fact, by that time very little will remain to be done to finish the job.

Operator-dialing of out-of-town calls will be increased.

There will be a greater amount of customer dialing of station-to-station long-distance calls. This service ultimately will be available to practically all customers.

Within the next few years special cables under the oceans to Europe, Alaska, and Hawaii will improve the quality and quantity of service to those areas.

There are a number of new developments which hold considerable promise for improved service, for further expansion of the telephone business, and for keeping the cost of telephone service at reasonable levels.

I believe you may have a transistor in front of you, which is this little insignificant-looking job right here. We spread a few out there on the table just before the hearing began.

Do you happen to have one of these, Mr. Chairman?

The CHAIRMAN. Yes, sir.

Mr. PHALEN. It is so small it is hard to find.

This little midget is a very important example of one of the newer developments. These devices generally perform the same functions as vacuum tubes, but with the major advantages of smaller size, greater durability, and greatly reduced power consumption. It is expected that the Bell System will make substantial use of transistors in many ways.

Another new development is the hollow-tube wave guide. Unlike wires and coaxial cables, these tubes possess the unique property of diminishing transmission losses as frequencies rise, thus permitting use of much higher and consequently wider range of frequencies. Our scientists tell us they believe that one day a single one of these wave guides will carry simultaneously tens of thousands of cross-country telephone conversations as well as hundreds of television channels.

The solar battery is another pioneering Bell System development. I think you have a pint-sized version of a solar battery before you, too.

The CHAIRMAN. Is that the one that was developed down in Georgia?

Mr. PHALEN. That is the one that is being used down in Georgia in connection with rural service right now, Mr. Chairman. I will say a word about that in just a moment.

It is the first device efficiently to convert energy from the sun directly into electrical power. At this early stage its ultimate potential can only be conjectured, but it has obvious advantages as a power supply when the requirement is very small and commercial power is unavailable. On October 4 of this year we inaugurated in Americus, Ga., the first test of the use of solar batteries to give improved telephone service to farmers. Undergoing test at the same time is a new "rural carrier" system using various frequencies to carry five telephone conversations on the same wire at the same time. These, along with other postwar developments, are part of our continuing effort to bring improved telephone service at reasonable cost to sparsely settled farm areas.

I might digress for a moment, Mr. Chairman, since you indicated an interest in the Americus, Ga., experiment, to say that all of us spend a considerable amount of time trying to improve rural service. Speaking for my own company, and I think the picture in the other companies is pretty much the same, we have made very substantial progress in the postwar years in the percent of rural establishments having telephones. We have also spent a lot of time and money to unload the lines. As you know, in past years many rural lines had perhaps 10 or 12 customers on them. Up in Michigan we have reached a point now where 96 percent of our rural lines are down to 8 or fewer customers on the line. We have converted, during the postwar years, about 50 of our offices, serving rural communities, from the older magneto offices, the office where you turn the crank to get the operator, to up-to-date and modern dial equipment.

The CHAIRMAN. Incidentally, that is the way they have a telephone fish now. Have you heard about that?

Mr. PHALEN. No.

The CHAIRMAN. They get one of these old magneto telephones and put the wire into a running stream and turn the crank. It does something to the fish. They come to the top and they can catch them. It is not a violation of the law in most States.

Mr. PHALEN. That is a new one to me.

The CHAIRMAN. They have them up in courts frequently for doing that. They catch fish all right.

Mr. PHALEN. That is another advantage of technological progress, because we are making more and more of those sets available for fishing purposes.

Another thing we are doing; you probably aren't too familiar with the geography in my State, but we have an upper peninsula that has a number of wide-open spaces, not quite as wide open as yours down in Texas, but we do have some wide-open spaces up there, and we are trying to move into those areas gradually and give service to folks that haven't had telephone service before.

The CHAIRMAN. It doesn't actually kill the fish. It just addles them. At least they get in confusion and all come to the top and run around.

Mr. PHALEN. I will have to look into that.

The CHAIRMAN. It will not work in still water, I am told. I am going to tell you hearsay, of course, because it is a violation of the law in my part of the country.

Mr. PHALEN. It probably wouldn't work in salt water, either, would it?

The CHAIRMAN. I don't know that. It has to be running water.

Mr. PHALEN. We call our State the Water Wonderland, so it will be of academic interest to me.

Another example of our developmental projects is the so-called M-4, a machine for automatically making wrapped wire connections in patterns determined by punched-tape instructions. These wrapped connections, which need no solder, are already in use with hand-controlled tools, but the machine is still in the experimental stage.

Awaiting its first installation, possibly in 1958, is an entirely new dial-switching system which, unlike our present dial equipment, will make little or no use of electro-mechanical switches. Instead, transistors and other electronic gear will provide the nerve system and direct the switching of calls.

These are some of the new things under active study or development in the Bell System. I believe that these will illustrate the direction of our efforts toward improved service, wider scope of services offered, and improved efficiency. However, I again want to emphasize that none of the improvements now being made and none of the developments that we foresee is of a nature that will revolutionize the business or substantially change its present character. They will be a continuation of the evolutionary changes that have been going on over the years.

One final word as to future employment prospects and the need for new capital.

In the future, as in the past, the nature of some telephone jobs will change. But, as in the past, we believe that scientific and technological improvements will come with ample time for adjustment and retraining of workers. Force adjustments will be handled so as to produce a minimum of hardship, applying procedures which have been used successfully in the Bell System over many years.

We estimate that it will be necessary for us to continue to attract large amounts of new money to the business. As we see it, we will have to add even more new capital during the years immediately ahead than the very large amounts which have been required in recent years. The expenditures will be mainly for growth, but there will be large amounts expended for improvements.

I think the facts of the past provide the best clue to the future. Technological changes in our business will continue. They will make telephone service better, will widen its scope and will keep the price reasonable. Coupled with aggressive selling, which is a part of our program, such developments should further increase the usage of the service, and it is increase in usage that creates jobs. There will probably be some scattered adverse effects on personnel and these we will try to minimize. In the future, as in the past, there will probably also be fluctuations in employment. However, the long-term trend in our business has been one of increasing markets, increasing job opportunities, and substantial capital investments. We see nothing in the present picture which should change this trend.

The CHAIRMAN. Thank you very much for your very interesting statement. It will be helpful to the subcommittee, I know.

We have some questions we would like to ask, but we are trying to get through. This is the third week of our hearings. We are trying to get through tomorow. If it is agreeable with you, we will submit those questions to you in writing, if you will answer them for the record when you return the record with your approval. Would that be satisfactory?

Mr. PHALEN. That would be entirely satisfactory to me, Mr. Chairman.

The CHAIRMAN. All right, then. Thank you very kindly for your appearance.

Mr. PHALEN. Thank you, sir, very much.

(Questions to be asked of representatives of the Bell System:)

1. Assuming that current levels of telephone business are maintained, what would be the ultimate labor force necessary in a situation of 100 percent local

dial and 100 percent customer toll dialing? How many of these would be telephone operators?

2. Can you give us a picture of what has taken place in the Bell System from an automation standpoint during the past 25 years; that is, how many exchanges and stations were converted to local and toll dial annually, how many workers did it formerly take to handle representative operations versus the number required today? (Example: (1) One operator formerly could handle so many long-distance calls a day, manually. How many does the same operator handle under operator toll dialing? (2) A certain number of accounting people were necessary to bill 100 customers; how many are needed to bill the same number with automatic message accounting machines?)

3. What additional automation plans, if any, does the Bell System have other than those popularly discussed; namely, other than local and toll dialing, and automatic message accounting?

4. Is there any group within the Bell System at the local company or at the A. T. & T. Co. level whose responsibility is to program technological changes? Who makes the decisions when and where to go ahead?

5. What factors influence their decisions regarding the timing of such programs?

6. Does the effect of technological change upon employment in the industry have little, substantial, or overwhelming influence on such decisions?

7. What explanation, if any, can management offer for the sharp decrease in employment, namely 33 percent, which took place between the 6-year period 1929 through 1935 compared with the much smaller decreases which took place in number of telephone and average daily telephone conversations?

8. Did the decrease in employment in the Bell System between 1953 and 1954 change any of the Bell System timing or planned timing regarding ultimate mechanization of all local and toll calls?

9. Can you give us figures regarding the number of workers actually laid off, in the Bell System annually from 1920 to date indicating how many of those employees were permanent employees and how many were temporary or so-called term employees who were hired for a specific period of time immediately prior to a dial conversion?

10. What do you estimate to be the final cost of conversion from local manual operation to local dial; the cost of installing customer toll dial?

11. Will all these mechanical changes in the Bell System permit a shorter work week among its workers?

(The following was later received for the record:)

MICHIGAN BELL TELEPHONE CO.,
Detroit, Mich., November 9, 1955.

DEAR MR. CHAIRMAN: At the close of my testimony before your committee on October 27, 1955, I was given a list of questions headed "Questions To Be Asked of Representatives of the Bell System." On examination I find that many of these questions (probably because they were prepared before I testified) are answered in whole or in part in my testimony. In this letter I will, therefore, refer to the testimony where to do so will avoid needless repetition.

Set forth below are the various questions together with the answers.

Question 1. Assuming that current levels of telephone business are maintained, what would be the ultimate labor force necessary in a situation 100 percent local dial and 100 percent customer toll dialing? How many of these would be telephone operators?

Answer. In my testimony I dealt in detail with the trend of employment opportunities in the Bell System and also gave our views as to what is the outlook for the future as we see it.

As to the past, chart 8 of the testimony shows the large increase in the number of employees during the years that the Bell System has been making the important change from manual to dial switching. Chart 9 shows that during these years the Bell System has been furnishing an increasing share of national employment. Chart 10 shows the large increase in the payroll of the Bell System telephone companies during these years. The trend has been one of increasing job opportunities and increased payroll.

As to the future, I stated that we expect technological changes to continue to make telephone service better, to widen its scope, and to help keep the price reasonable. The testimony also stated that we expected this to increase the usage of our service—and that it is increased usage which creates jobs.

In view of the fact that the history of our business for the long pull has been one of increased usage rather than the maintenance of current levels of telephone business, we have made no estimate of the kind suggested in this question. Furthermore, to make such an estimate would be impractical. For example, we do not foresee 100 percent customer toll dialing because many types of calls, as outlined in my testimony, cannot be handled automatically. The question would further require the assumption that the scope and nature of the services rendered by the Bell System will remain in the future as they are today. As the testimony shows, technological progress has continually increased the variety of service we offer. Any estimate made on the basis that this will not be true in the future would be unrealistic.

If we were to assume that the business had stagnated and that there was no prospect for long-term expansion, we would have to reexamine and revise all our plans for the future. However, we know of no facts that would suggest a valid reason for so doing.

Question 2. Can you give us a picture of what has taken place in the Bell System from an automation standpoint during the past 25 years; that is, how many exchanges and stations were converted to local and toll dial annually, how many workers did it formerly take to handle representative operations versus the number required today? (Example: (1) One operator formerly could handle so many long-distance calls a day, manually. How many does the same operator handle under operator toll dialing? (2) A certain number of accounting people were necessary to bill 100 customers; how many are needed to bill the same number with automatic message-accounting machines?)

Answer. In brief, this question asks that I give a picture of what has happened in the Bell System by way of automation over the past 25 years.

Much of the testimony which I gave before the committee is relevant to answering this question. In fact, the data there developed covered a 35-year rather than a 25-year period. In particular, facts were given with respect to the important change from manual to dial switching.

Specific information called for by the question appears in the charts submitted as part of my testimony, including the following:

(*a*) Chart 6 shows the increase in the number of telephones in the Bell System since 1920. Similarly chart 1 shows the increase in percentage of dial telephones. A comparision of these charts will show the extent of dial installation over the years.

(*b*) Chart 8 shows the numbers of employees in the Bell System companies since 1920. These figures may readily be compared with the number of telephones at the various periods. Figures also were given preceding chart 8 with respect to the increased number of telephone operators.

(*c*) Reference is also made to chart 9, showing that the Bell System has been furnishing an increasing share of national employment; to chart 10, showing the large increase of payroll in the Bell System telephone companies; to chart 7, showing that telephones have increased even faster than the volume of gross national product; and to chart 5, showing the growth in the number of long distance conversations.

Computations along the lines suggested by question 2 could be made from the facts given in the testimony. However, various factors would render the results of such computations of no significance.

The facilities and methods used by our employees have been greatly changed over the years by technological improvements. The scope and nature of telephone jobs, therefore, are very different from those of earlier years. Moreover a comparision of chart 8 with chart 12 will show that the investment in plant per employee is now about four times what it was in 1920. Further, as emphasized in my testimony, it is important to remember that dial-switching equipment is just one component in what really is a single integrated plant, comprising a vast network of communication channels and related equipment. Telephone service of present-day quality and scope is dependent not only upon modern dial equipment, but is also dependent on improved transmitters and receivers, on improved cables, on the loading coil which reduces transmission losses, and on the telephone repeater which amplifies voice currents at intervals along the route. It is also dependent upon apparatus which makes possible numerous telephone circuits on two pairs of wires, upon modern coaxial cables, on the radio relay, and on many other devices and techniques which have been developed and improved over the years for the carrying on of our business.

Only by looking at our business from the overall and long-range point of view can there be any real understanding of what automation in the Bell System has meant. For this reason I gave facts and figures showing how automation had benefited the users of service, the employees in the business, the investors in the business and the public generally.

Question 3. What additional automation plans, if any, does the Bell System have other than those popularly discussed; namely, other than local and toll dialing, and automatic message accounting?

Answer. The final part of my testimony was devoted to what we see in the future. This part of the testimony described our plans with respect to further dial installations, customer toll dialing, the special undersea cables to Europe, Alaska, and Hawaii, the transistor, the hollow-tube wave guide, the solar battery, rural carrier systems, the M-4 machine for automatically making connections in patterns determined by punched-tape instructions and the new electronic dial-switching systems. It was pointed out, however, that none of the improvements being made and none of the developments which we foresee would be of a revolutionary nature. I emphasized that they would be a continuation of the evolutionary changes that have been going on over the years.

Question 4. Is there any group within the Bell System at the local company or at the A. T. & T. Co. level whose responsibility is to program technological changes? Who makes the decisions when and where to go ahead?

Question 5. What factors influence their decisions regarding the timing of such programs?

Question 6. Does the effect of technological change upon employment in the industry have little, substantial, or overwhelming influence on such decisions?

Question 10. What do you estimate to be the final cost of conversion from local manual operation to local dial; the cost of installing customer toll dial?

These questions all relate to the planning for technological improvements. I believe they can best be covered by one answer.

Answer. Technological changes are an outgrowth of the needs of the Bell System telephone companies as well as of ingenuity and inventiveness throughout the Bell System, and particularly in the Bell Telephone Laboratories. As new developments for faster and improved telephone service near completion, they are made known to all of the Bell System telephone companies. Thereafter, depending upon local conditions, each of these companies decides for itself where the new developments will be useful and the timing of any installations.

In actual practice, each Bell System telephone company formulates for itself a broad construction program for several years in advance. The program is designed not only to care for the growth of the business but to incorporate into plant new developments to improve service and to maintain overall costs at a reasonable level. In this way new developments are usually introduced in connection with additions or changes required as a means of caring for growth. Even in the case of replacing a manual office with dial, the economics of the replacement are usually such that it is made at a time when the manual board is expected to reach its capacity.

The broad construction program of each company is originally coordinated by its chief engineer. It is then reviewed by the company's officers and board of directors in the light of all considerations, including the requirements for growth, the financial aspects of the program, the availability of material and manpower, the effect of the program on employment, and the effect on the quality of telephone service. This program is, of course, subject to continuing review and is revised from time to time as changes occur in the various assumptions and factors involved.

The time consumed for developing each major project making up such a broad program is substantial. For example, the interval between the date of letting of contracts and the cutover for a large dial installation may be nearly 2 years. Often the project involves construction of a building. A major project such as dial installation is made known to the employees and to the public 2 or 3 years prior to scheduled completion. This gives ample time for human as well as technical planning. I dealt in my testimony with the substantial effort and attention given to the effect of dial conversion on the employee body.

As to the cost of conversion from local manual operation to local dial or the installation of customer toll dial, the local and long-distance telephone plant is a completely integrated whole. No separate studies are made on mechanization alone. Every local dial conversion has provision for additional growth. Many projects include provision for changed and improved service arrangements, such as extended area service which involves the inclusion in the local calling area of certain calls to nearby points which formerly were handled on a long-distance basis. Part of the instrumentalities necessary for customer toll dialing are frequently placed coincident with a local dial conversion. Wayne, Mich., is an example where the local manual office was replaced by dial and the equipment provided has features which will permit customer dialing of long-distance calls. No estimates were made of the proportion of the total cost of the dial conversion which could be allocated to the extension of customer toll dialing.

Accordingly, we have no estimate as requested of the final cost of conversion from local manual operation to local dial or the cost of installing customer toll dial.

Question 7. What explanation, if any, can management offer for the sharp decrease in employment, namely 33 percent, which took place between the 6-year period 1929 through 1935 compared with the much smaller decreases which took place in number of telephone and average daily telephone conversations?

Answer. The telephone business is affected to a very substantial degree by general business conditions. Adverse business conditions cause a reduction in force requirements.

Long-distance usage is particularly sensitive to general business conditions. As an example, in the period cited from 1929 through 1935, telephones in service dropped some 10 percent, but long-distance conversations, and these are the ones which involve the most employee time, dropped nearly 30 percent. Changes in usage are directly reflected in force requirements.

There are other reasons for reductions in force requirements during periods of severe economic recession. One is the lower force turnover which results in fewer learners in the business and fewer people needed to train them. Another is that people tend to be absent less frequently. Further, in an extended period without growth the number of employees required for engineering and construction work is substantially reduced.

These factors were all present during the period from 1929 through 1935 and affected the relationship between the reduction in the number of employees and the decreases which took place in the number of telephones and telephone conversations.

One point should be made clear: The decline in the number of employees referred to does not mean that that number of employees was laid off. It means that the employees on the payroll at the end of the period were that many fewer than those at the beginning. This decrease was brought about by resignations, deaths, and retirements as well as by layoffs and the number of employees who left the company for other reasons was substantially greater than those due to layoffs.

Question 8. Did the decrease in employment in the Bell System between 1953 and 1954 change any of the Bell System timing or planned timing regarding ultimate mechanization of all local and toll calls?

Answer. The small decrease of about 1.6 percent in employment in the Bell System between 1953 and 1954 was the net result of the interplay of many factors including principally the lower level of general business. The period of the reduced business, however, was so short as to have had no appreciable effect on the planning of the various companies regarding mechanization.

It is of interest in this connection that whereas there was a decrease of 1.6 percent in employment during 1954, there has been an increase of 5.7 percent in employment in the first 8 months of 1955.

Question 9. Can you give us figures regarding the number of workers actually laid off, in the Bell System annually from 1920 to date indicating how many of those employees were permanent employees and how many were temporary or so-called term employees who were hired for a specific period of time immediately prior to a dial conversion?

Answer. May I refer the committee to specific statements that I made in my direct presentation with regard to layoffs due to dial conversions. I indicated there that, as a result of human as well as technical planning and taking full advantage of all opportunities to reduce the number of potential displacements, "few if any regular employees must be laid off" as a result of dial conversion, which is the most important technological change that has taken place in our business. "In the past 5 years, there have been on the average less than a thousand (layoffs) a year throughout the system out of over a quarter of a million telephone operators employed, and usually those laid off have been offered transfers." The figure quoted is for the total layoffs of regular employees that occurred in the switchboard operating force for all reasons—this is used here since there have been very few layoffs during this particular period for reasons other than dial conversion. Other than this kind of information, we do not have on a system basis specific data on layoffs due to dial conversion.

May I also reemphasize the statement of Frances Perkins when she was Secretary of Labor, "Of the hundreds of occupations in which women are listed in the census of occupations, only about a dozen employ more women than do the telephone companies. The human problem of the displaced worker when the cutover was made from the manual to the dial system telephone exchanges is an almost perfect example of technological change made with a minimum of disaster. It was accomplished through human as well as technical planning." It is of significance that this statement was published in 1934 when the Nation as a whole was in the depths of the great depression.

Question 11. Will all these mechanical changes in the Bell System permit a shorter workweek among its workers?

Answer. During the 27 years that I have been in the telephone business there has been a substantial amount of automation and mechanical change and yet there has been only one basic reduction in the length of the workweek. That change occurred at a time when there was substantial unemployment throughout industry in general. My own experience, therefore, indicates that changes in the basic workweek come very gradually. So long as the long-term trend in our country is one in which the economy continues to absorb the available labor force and the demand for goods and services remains high, a shorter basic workweek seems unlikely.

I again wish to thank the committee and the staff for the opportunity to present the facts with respect to automation in the Bell System. I hope that the information I have given will be helpful to the committee in its study.

Sincerely yours,

C. W. PHALEN.

EDITOR'S NOTE.—(See charts in prepared statement following.)

(The prepared material submitted by Mr. Phalen follows:)

AUTOMATION AND THE BELL SYSTEM

Statement of Clifton W. Phalen, president, Michigan Bell Telephone Co.

My name is Clifton W. Phalen and I am president of Michigan Bell Telephone Co. I am appearing on behalf of the Bell System, which includes the American Telephone & Telegraph Co., its 20 telephone subsidiaries, the Bell Telephone Laboratories, and Western Electric Co., our manufacturing and supply organization. These companies employ more than 725,000 men and women, of whom more than 230,000 have worked in the system 10 years or more.

I wish to thank the committee and the staff for the opportunity to appear here today. I hope that what I have to say will be helpful to the committee in its study of automation.

As the committee pointed out last April in its release announcing its study, "automation" is a relatively new word. It is variously defined. To me it means general technological progress of the kind that has been taking place in our industry and in others for many years. It is in this broad sense that I would prefer to use the word.

Automation, however, apparently suggests to some people that factories and even some industries of the future will run automatically, with only a few persons needed to control operations.

I wish to emphasize at the very beginning of my remarks that nothing resembling this result is in prospect for the telephone industry. We see changes ahead, but not changes of a revolutionary nature. Although we use large quantities of automatic equipment, the dial telephone being a good example, we are convinced that our business will continue to be operated by very large numbers of employees.

Before entering into a detailed discussion of automation in the Bell System, I should like to stress several basic thoughts.

The first has to do with the reasons for automation in our companies. We have introduced dial equipment and many other scientific and technological improvements throughout the years for three basic reasons: To improve the quality and usefulness of telephone service, to satisfy the demand for service, and to keep the cost of our product at a reasonable level.

The result has been a marked expansion of telephone usage over the years. Telephones and telephone calls have increased many times more rapidly than population, and even more rapidly than gross national product. I will give the facts in detail later.

The increased telephone usage resulting from scientific and technological progress has, in turn, helped to expand employment. This will be clear by comparing the present-day situation with that in 1920, the year conversions of telephones to dial operation first began in the Bell System. At the present time about 85 percent of Bell System telephones are dial operated. Operators are now dialing directly nearly 60 percent of long-distance calls. Customers now dial directly about a quarter of all calls outside local areas. Yet employees number nearly 3 times as many as in 1920, when there were no dial telephones, and over twice as many as in 1940, when about 60 percent of telephones were dial.

In studying automation in the Bell System it should be borne in mind that we render an essential public utility service, subject to regulation as to operations and rates by public authorities. It follows that technical advances in the business and economies in operation are necessarily and properly shared in large measure with the public.

With these preliminary remarks I will go to a review of past technological developments in the Bell System. I will then discuss the effects they have produced, having in mind that the committee has indicated an interest in the distribution of gains from such developments among workers, investors, and consumers. Finally I will give our views as to possible future developments.

PAST SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENTS

General

Undoubtedly the most important technological change that has taken place in our business has been the change from manual to dial switching. This is the only development that I will discuss in any detail.

Although I will so limit my discussion, it is important to remember that dial switching equipment is just one component in what is really a single integrated plant, comprising a vast network of communication channels and related equipment.

Telephone service of present-day quality and scope is therefore dependent not only upon modern dial equipment but also upon improved transmitters and receivers, on improved cables, on the loading coil which reduces transmission losses, and on the telephone repeater which amplifies voice currents at intervals along the route. It is dependent upon apparatus which makes possible numerous telephone circuits on two pairs of wires, upon the modern coaxial cable—a small cable which can carry many hundreds of telephone calls simultaneously, on the radio relay with its beaming of long-distance telephone calls and television programs without the use of wires or cables, and on many other devices and techniques which have been developed and improved over the years for the carrying on of our business.

Developments in automation

Now as to the development of dial switching.

Early in the telephone business the complex problem of connecting customers with each other was met by means of switchboards, where customer lines would terminate and where any two could be linked together. The early switchboards were all manually operated.

As the business grew, it became evident that manual operation would be less and less suited to handle the volumes of traffic being developed and foreseen for the future, to say nothing of permitting improvement in quality of service. After much investigation and experimentation, a dial system designed to meet our service requirements was introduced in 1920, permitting customer dialing of local telephone calls. Dial apparatus has undergone substantial change and improvement since then.

The first of the charts I have prepared for the committee (chart 1) shows the increase in dial telephones in the Bell System. It reflects the gradual but steady progress made in installing dial equipment.

Dial switching has been important to long-distance service as well as to local service. Technological developments now permit operator dialing of nearly 60 percent of all long-distance calls. For example, when a customer places a call with a Washington operator for a San Francisco number, the operator dials that number directly from her switchboard and the called telephone in San Francisco rings automatically in a matter of seconds. Customers' telephones in upward of 3,900 towns and cities can now be reached in this way.

Telephone users themselves are also dialing directly about one-quarter of the calls that go outside their local areas. While most of these calls are to

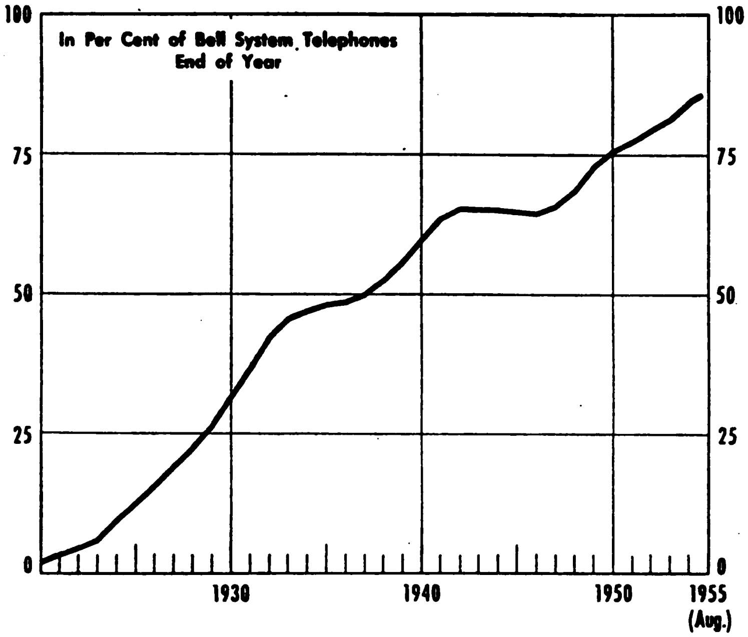

THE PROPORTION OF DIAL TELEPHONES HAS INCREASED....

CHART 1

neighboring localities, in the past few years we have seen the beginning of customer dialing of station-to-station long-distance calls. This service has already been introduced in certain suburban exchanges near cities which include New York, Washington, Balitimore, Pittsburgh, Detroit, Chicago, St. Louis, and San Francisco. Customers in those exchanges may now dial their own station-to-station calls to many distant points in addition to dialing short-haul calls to nearby localities.

Nationwide dialing of station-to-station long-distance calls requires a uniform numbering plan, a large network of dial switching centers, and automatic equipment for registering certain information as to the calls. The automatic equipment, which also keeps a count of certain chargeable local calls, is the so-called AMA apparatus—automatic message accounting. It employs punched tapes which register the calling telephone, the called telephone, the time connection was established and the time connection ended. A machine takes the information off the tape and assembles it for each customer.

The long-distance calls which will be customer dialed, and serviced by the AMA apparatus, are station-to-station calls not involving operator assistance. Operators will still be needed on other types of long-distance calls, including person-to-person calls. These other types of calls are the ones which require the longer periods of operator time.

EFFECTS OF SCIENTIFIC AND TECHNOLOGICAL PROGRESS

Your committee has evidenced an interest in how the gains of automation have been shared among customers, employees, and investors. For our companies I will give data for each of these groups for today and for 1920, the year when dial mechanization of the Bell System began.

EFFECTS ON THE USERS OF SERVICE

Let us first look at what has happened to our customers—the users of the service.

Quality and scope of service have improved

Scientific and technological progress has improved the quality of service and has extended the scope and usefulness of service.

A few examples will illustrate the improvements in quality. Dial switching now provides a faster and more uniform service, with full load-carrying capacity available 24 hours a day. The speed and accuracy of the remaining operator-handled services have been improved through better apparatus and equipment. In the early 1920's the average time required to complete a long-distance call was about 10 minutes; now it's a little over a minute, with some calls which are dialed directly going through in as little as 15 seconds. Today more than 95 percent of the long-distance calls are handled while the customer remains on the telephone; in 1920, less than 10 percent were so handled. In 1920, carrying on an average long-distance conversation was like conversing with a person in an open field at a distance of 80 feet; today the equivalent distance has been reduced to 10 feet. Subscribers' trouble reports—something wrong with the equipment which prevents satisfactory service—have been reduced 70 percent.

Technological progress has not only improved the quality of service, but has also increased the variety of the services we offer. As of today there are more than 400 separate services available to our customers. Let me mention just a few by way of example: telephone service for ships and automobiles, service to foreign countries, teletypewriter exchange service, dial switchboards for individual customers, intercommunication systems and wiring plans, automatic answering devices, time and weather service, conference service, picture transmission service, radio and television network service, "speakerphones" (hands-free telephones), volume control telephones, and school-to-home services for convalescing children.

Automation, therefore, has not only given the customer better service but a wider and wider variety of services.

Cost of service has remained reasonable.

Now let us look at what has happened to the cost of service.

The Bureau of Labor Statistics started in 1935 to price the cost of local residence telephone service as a part of the so-called market basket of goods and services included in the Consumers Price Index. I call your attention to the second of the charts (chart 2). It shows the changes since 1935 in the cost of local residence telephone service and in the cost of all goods and services in the market basket. Telephone service is shown with Federal excise taxes excluded, as being a more accurate reflection of changes in the cost of the service itself. This chart shows that while the cost of all goods and services was going up 95 percent, the cost of local telephone service rose less than one-third as much, or 30 percent.

I believe, therefore, that the technological changes which the period since 1920 has brought have affected the customer in these ways: He has received constantly improving service, he has received a wider variety of services, and the cost of service has been kept at reasonable levels.

Result has been expanded usage.

The customers have reacted to this in a very natural but most significant way. Their usage of the service has increased tremendously. Progress and reasonable prices have stimulated demand. Let me illustrate this with a few charts.

Chart 3 shows the increase in telephones since 1920. Bell System telephones now number more than 45,000,000—more than 5 times as many as in 1920.

Chart 4 shows that more than 70 percent of American households now have telephones, as against less than half that percentage in 1920.

Chart 5 shows that the number of long-distance conversations has increased manyfold since 1920.

Chart 6 compares the increase of telephones with the increase in population. It shows that the growth in telephones has been much more rapid.

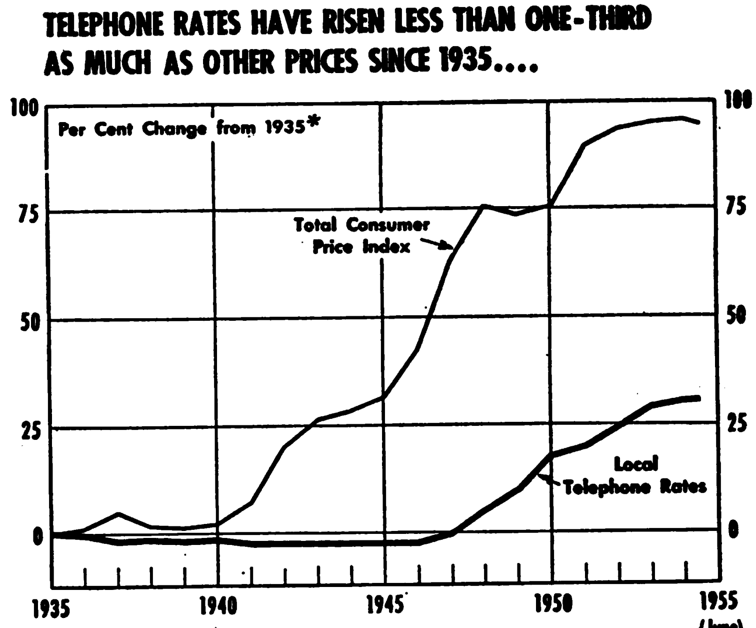
Chart 7 compares the increase in telephones with the increase in gross national product. It shows that the growth in telephones has even exceeded the large increase in gross national product.

The charts we have just seen show a substantial increase in telephone usage. Technological progress has played an important part in this increase.

EFFECT ON EMPLOYEES

Let us now see how employees have fared.

More usage has created more jobs, and the number of our employees is now at an alltime high. Before going into the details I would like to explain what the Bell System does to meet the problems of individual employees affected by automation. For example, here is what we do in connection with the introduction of dial systems:



Source: U.S. Bureau of Labor Statistics

*First Year Telephone Rate Component Included in C.P.I.

CHART 2

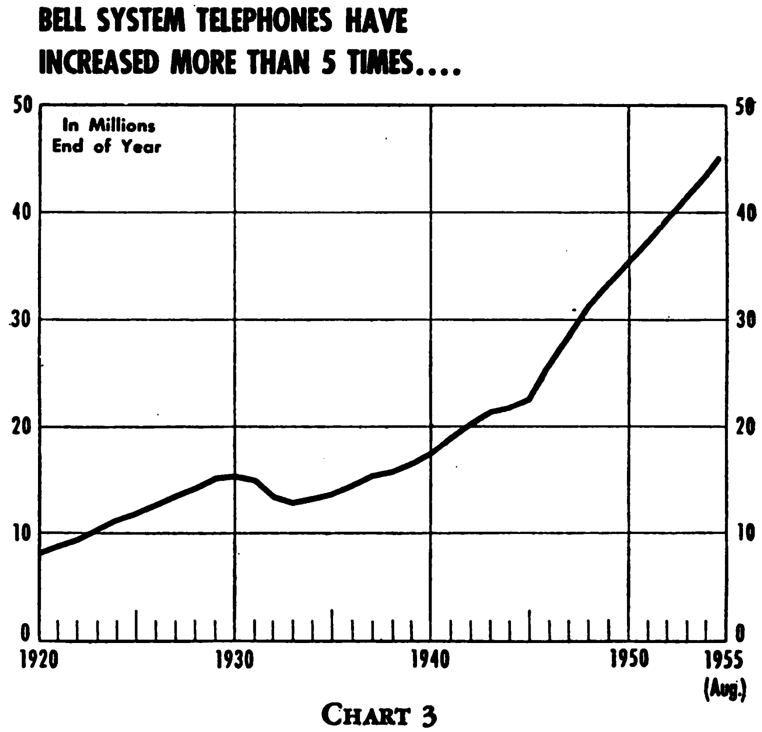


CHART 3

THE PROPORTION OF HOUSEHOLDS WITH TELEPHONE SERVICE HAS INCREASED....

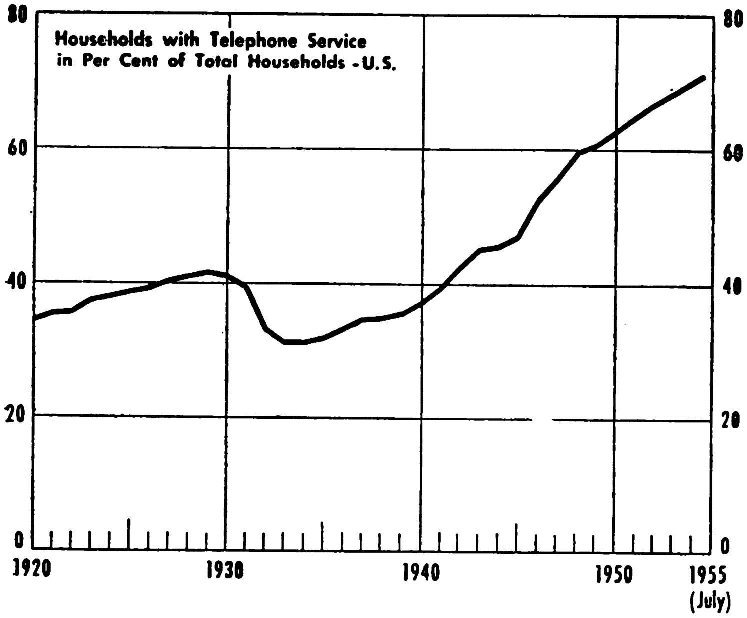


Chart 4

LONG DISTANCE CONVERSATIONS HAVE INCREASED MANY FOLD....

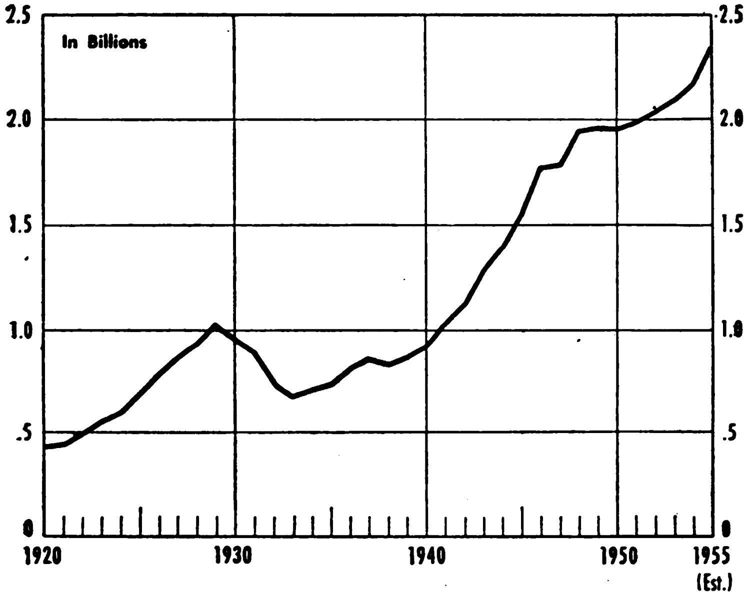


Chart 5

TELEPHONES HAVE INCREASED SUBSTANTIALLY FASTER THAN POPULATION....

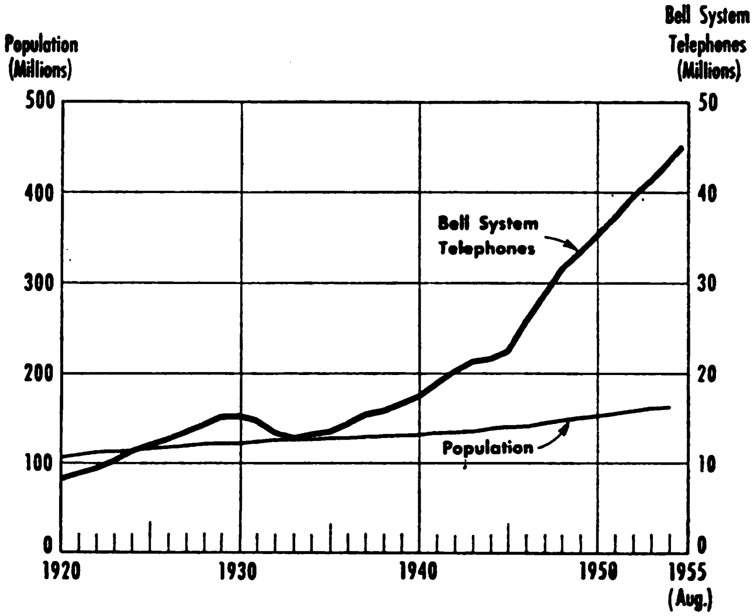


CHART 6

TELEPHONES HAVE INCREASED EVEN FASTER THAN THE VOLUME OF GROSS NATIONAL PRODUCT....

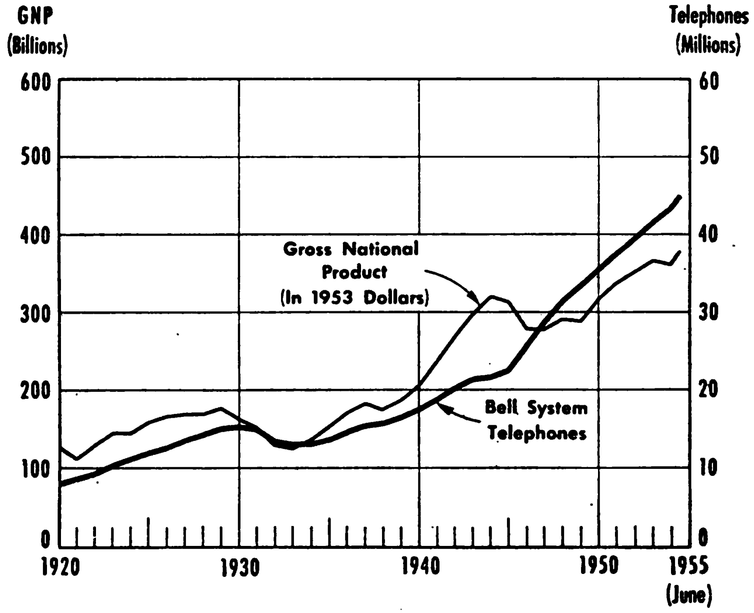


CHART 7

My own company, like other Bell companies, has developed, over the 35 years that dial conversions have taken place, a guide for carrying out conversions. At the heart of all plans is the awareness that the company has a social responsibility to eliminate or alleviate adverse effects on its personnel.

In establishing the date for a conversion, the controlling consideration is to make that date sufficiently far in advance, generally about 3 years, to provide ample time for human as well as technical planning.

The conversion having been scheduled, the first step is to inform the employees. Usually, most of the employees on the payroll at that time can be given assurance of continued employment; this is partly because the force progressively reduces itself by resignations in the normal course and partly because of the opportunities for reassignments. During the preconversion period, all losses from the force are replaced, so far as possible, with people hired for temporary employment. These temporary employees are chiefly people who desire work for only limited periods, such as young women expecting to be married soon or former employees who are willing to return to telephone work to help out for a short period of time. Regular employees who state their intention of resigning or taking an early service pension prior to the cutover date are urged to defer this action wherever possible until the dial conversion. These steps are all designed to reduce the number of potential displacements. Advance planning is also done to provide transfer opportunities for employees. These transfers may be to other types of work or to other offices in the same or other communities. Any retraining is done at the expense of the telephone company.

In most cases, as a result of these measures, few, if any, regular employees must be laid off. The employees principally affected are telephone operators. The number of such layoffs is relatively small. In the past 5 years, there have been, on the average, less than a thousand a year throughout the system out of over a quarter of a million telephone operators employed. And usually those laid off have been offered transfers. To the individuals involved, however, the layoff can be a source of much difficulty. To meet such conditions, the Bell System companies for many years have had severance-pay plans under which employees who are laid off receive lump-sum payments varying in accordance with their length of service and wage rates.

An observation which I think will interest you was made some years ago about the Bell System treatment of employees in connection with dial conversions. When she was Secretary of Labor, Frances Perkins wrote: "Of the hundreds of occupations in which women are listed in the Census of Occupations, only about a dozen employ more women than do the telephone companies. The human problem of the displaced worker when the cutover was made from the manual to the dial-system telephone exchanges is an almost perfect example of technological change made with a minimum of disaster. It was accomplished through human as well as technical planning."[1]

With this background, I would like to take a broader look at the effect on the employee body of the conversions to dial switching.

The introduction of a dial system reduces the number of operators required for a given number of calls at a given location. It would be a mistake, however, to conclude that dial conversions have reduced the number of employees needed in the telephone business. To do so would be to ignore the important factor of growth in our business and to ignore the further fact that dial systems and other technological changes have been most important in producing growth.

Large numbers of telephone operators are still required with dial operation. Many types of calls cannot be handled automatically, such as information calls, calls needing assistance, some calls from coin telephones, person-to-person calls, and reverse charge calls.

Let us look at the facts. At the beginning of 1920, when there were no dial telephones, 115,000 persons were in the employ of the Bell System as telephone operators. At the end of 1954, 228,000 were employed as operators. At the end of August 1955, 237,000 were so employed.

These figures are significant. However, the facts I will now give illustrate far better the overall situation with respect to employment.

Chart 8 shows how total employment in the Bell System telephone companies has increased since 1920. The facts are given for the American Telephone & Telegraph Co. and its telephone subsidiaries. The chart shows both peaks and valleys, but viewing the whole period the number of persons employed by Bell System telephone companies has increased almost three times since 1920. Since the beginning of 1955 employment in the companies has risen by about 33,000.

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[1] People at Work, p. 209, published by the John Day Co., Inc., 1934.

Chart 9 shows the rise in employment in the Bell System telephone companies relative to total civilian employment in the United States. We have been furnishing an increasing share of national employment. The Bell System's proportion of the total civilian employment is 76 percent higher now than in 1920.

EMPLOYEES OF BELL SYSTEM TELEPHONE COMPANIES HAVE INCREASED SUBSTANTIALLY....

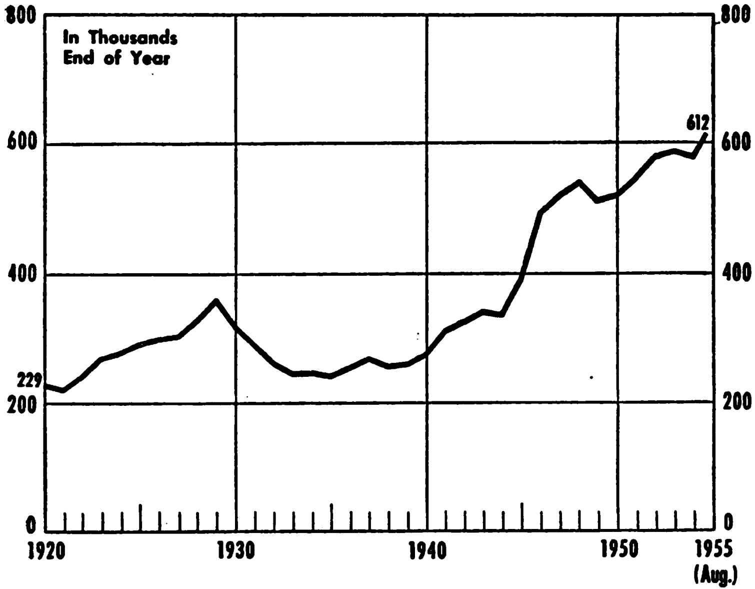


CHART 8

BELL SYSTEM IS FURNISHING AN INCREASING SHARE OF NATIONAL EMPLOYMENT....

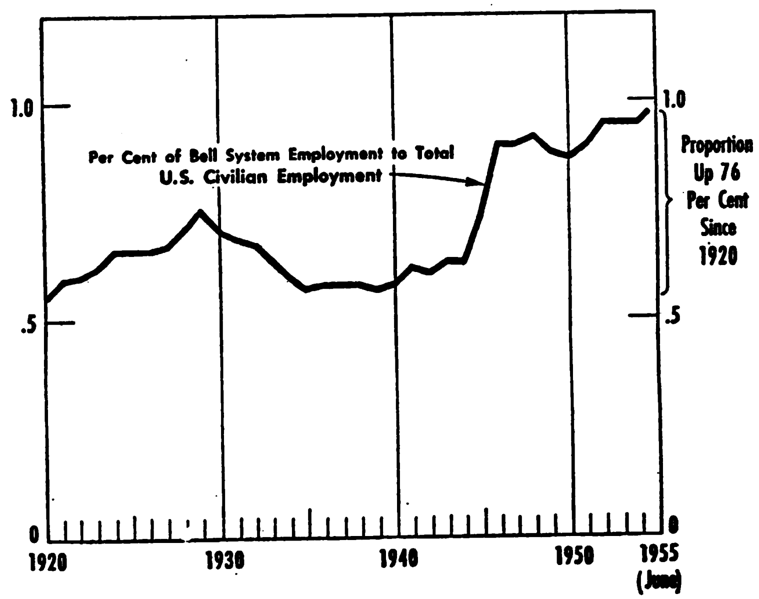


CHART 9

Chart 10 shows that the payroll of the Bell System telephone companies has increased nearly 10 times—from $261 million in 1920 to $2,525,000,000 in 1955. This reflects not only the increased number of employees but much higher wage rates.

Chart 11 compares average annual earnings of employees in the Bell System telephone companies with those of full-time employees in industry generally. It shows that earnings of Bell System employees have kept pace with those of workers in industry generally.

I would sum up the effect of technological improvement on our employees this way. It has brought increasing customer usage which, in turn, has created more jobs. And they are better jobs—jobs that pay much higher wages and jobs that compare favorably with those in other industries. Moreover the "real wages" of telephone employees have increased appreciably and their purchasing power is at new high levels. This increased purchasing power benefits not only our people but is good for the economy as a whole.

EFFECTS OF DEVELOPMENTS ON CAPITAL INVESTMENT

It has been through the incorporation of improvements into plant that the savings of the telephone investors have been profitably employed and the integrity of the money invested in the business has been maintained.

Scientific and technological developments have also created a continuing need for further investment in the business. Chart 12 shows the growing investment in our plant, which is now more than 10 times what it was in 1920. In the 10 years since World War II we have added new capital at the rate of more than $800 million a year. This year we will add more than that.

Chart 13 shows the increasing number of share owners of American Telephone & Telegraph Co., now numbering close to 1,400,000.

EFFECT OF TECHNOLOGICAL PROGRESS ON NATION AS A WHOLE

I have commented on the effect of progress in the telephone art on three groups—customers, employees, and investors. I now wish to make some observations as to the benefits this progress has brought to the Nation as a whole. These general benefits are in addition to the increased purchasing power of our employees already mentioned.

The fast, accurate, and dependable telephone service now furnished in this country is vital to the common life of the Nation and to the national defense. Further, developments in the telephone art have made important contributions to such projects as the DEW line, the air-warning system across the Arctic. Telephone techniques have also led to better military equipment such as the weapons systems used for the automatic aiming and firing of guns, the control of bombs, and the control of guided missiles such as the NIKE.

The Nation as a whole has also benefited from developments in the telephone field which have been of appreciable importance to products of other industries. Examples are motion pictures, hearing aids, radio, television, and automatic devices of many kinds.

FUTURE OUTLOOK

I will close by discussing some of the things that we see for the future.

Our present plans contemplate completion of the program for converting the remaining manual offices to dial. Five years from now more than 95 percent of our telephones will be dial operated. In fact, by that time very little will remain to be done to finish the job.

Operator dialing of out-of-town calls will be increased.

There will be a greater amount of customer dialing of station-to-station long-distance calls. This service ultimately will be available to practically all customers.

Within the next few years special cables under the oceans to Europe, Alaska, and Hawaii will improve the quality and quantity of service to those areas.

There are a number of new developments which hold considerable promise for improved service, for further expansion of the telephone business, and for keeping the cost of telephone service at reasonable levels.

Transistors are an important example of the newer developments. These devices generally perform the same functions as vacuum tubes, but with the major advantages of smaller size, greater durability, and greatly reduced power consumption. It is expected that the Bell System will make substantial use of transistors in many ways.

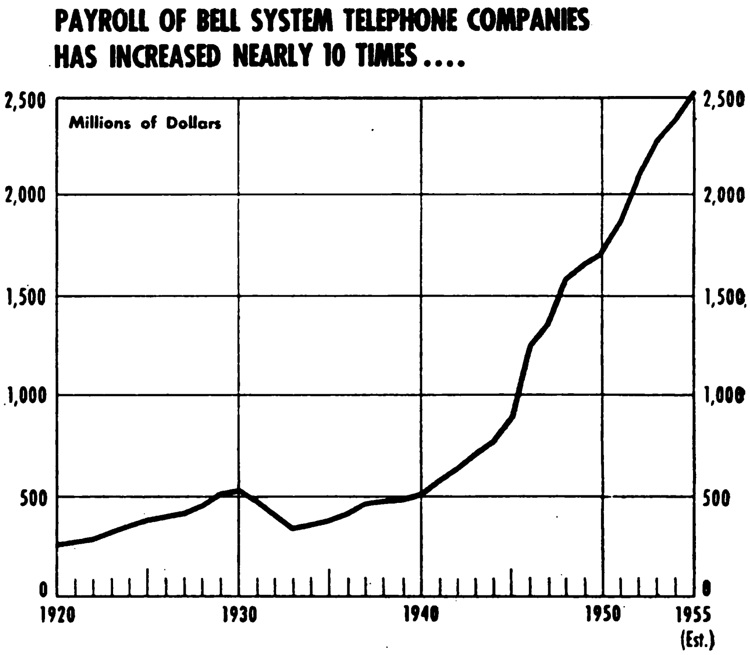
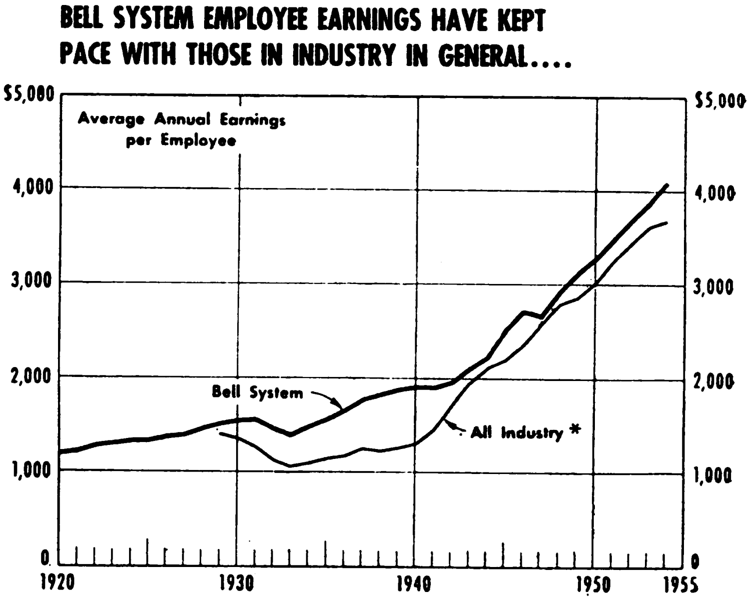
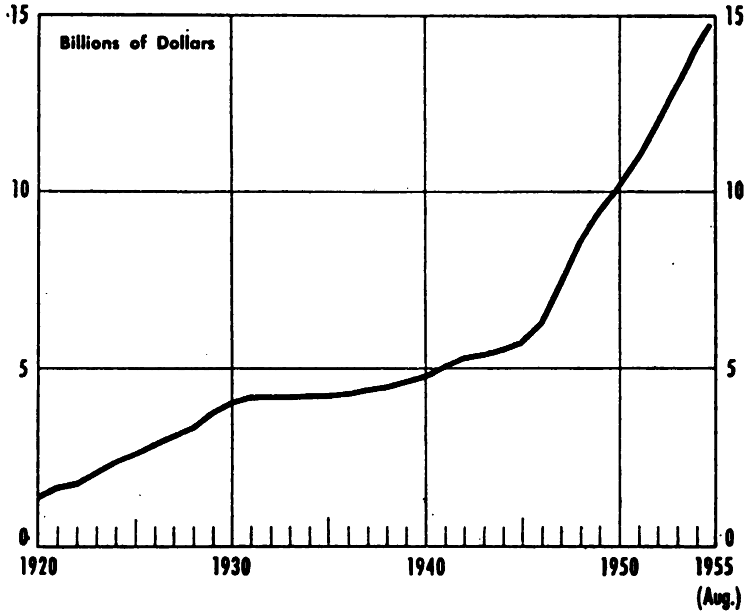


CHART 10



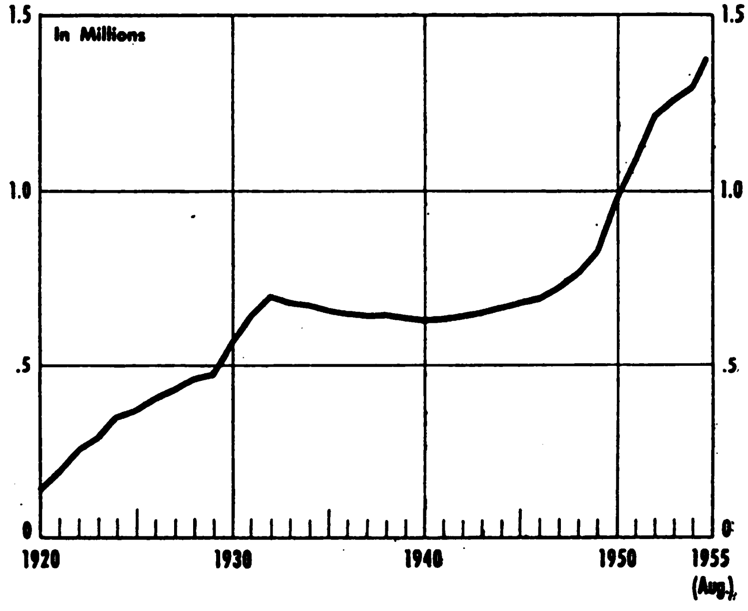
Source: * United States Department of Commerce

CHART 11



BELL SYSTEM PLANT INVESTMENT HAS INCREASED MORE THAN 10 TIMES....

CHART 12



A. T. & T. CO. SHARE OWNERS HAVE INCREASED ABOUT 10 TIMES....

CHART 13

Another new development is the hollow-tube wave guide. Unlike wires and coaxial cables, these tubes possess the unique property of diminishing transmission losses as frequencies rise, thus permitting use of much higher and a consequently wider range of frequencies. Our scientists tell us they believe that one day a single one of these wave guides will carry simultaneously tens of thousands of cross-country telephone conversations as well as hundreds of television channels.

The solar battery is another pioneering Bell System development. It is the first device efficiently to convert energy from the sun directly into electrical power. At this early stage its ultimate potential can only be conjectured, but it has obvious advantages as a power-supply when the requirement is very small and commercial power is unavailable. On October 4 of this year we inaugurated in Americus, Ga., the first test of the use of solar batteries to give improved telephone service to farmers. Undergoing test at the same time is a new "rural carrier" system using various frequencies to carry five telephone conversations on the same wire at the same time. These, along with other postwar developments, are part of our continuing effort to bring improved telephone service at reasonable cost to sparsely settled farm areas.

Still another example of our developmental projects is the so-called M–4, a machine for automatically making wrapped wire connections in patterns determined by punched-tape instructions. These wrapped connections, which need no solder, are already in use with hand-controlled tools, but the machine is still in the experimental stage.

Awaiting its first installation, possibly in 1958, is an entirely new dial switching system which, unlike our present dial equipment, will make little or no use of electro-mechanical switches. Instead, transistors and other electronic gear will provide the nerve system and direct the switching of calls.

These are some of the new things under active study or development in the Bell System. I believe that these will illustrate the direction of our efforts toward improved service, wider scope of services offered, and improved efficiency. However, I again want to emphasize that none of the improvements now being made and none of the developments that we foresee is of a nature that will revolutionize the business or substantially change its present character. They will be a continuation of the evolutionary changes that have been going on over the years.

One final word as to future employment prospects and the need for new capital.

In the future, as in the past, the nature of some telephone jobs will change. But, as in the past, we believe that scientific and technological improvements will come with ample time for adjustment and retraining of workers. Force adjustments will be handled so as to produce a minimum of hardship, applying procedures which have been used successfully in the Bell System over many years.

We estimate that it will be necesary for us to continue to attract large amounts of new money to the business. As we see it, we will have to add even more new capital during the years immediately ahead than the very large amounts which have been required in recent years. The expenditures will be mainly for growth, but there will be large amounts expended for improvements.

I think the facts of the past provide the best clue to the future. Technological changes in our business will continue. They will make telephone service better, will widen its scope and will keep the price reasonable. Coupled with aggressive selling, which is a part of our program, such developments should further increase the usage of the service, and it is increase in usage that creates jobs. There will probably be some scattered adverse effects on personnel and these we will try to minimize. In the future as in the past there will probably also be fluctuations in employment. However, the long-term trend in our business has been one of increasing markets, increasing job opportunities and substantial capital investments. We see nothing in the present picture which should change this trend.

The CHAIRMAN. We next have as our witness Mr. S. R. Hursh.

Mr. Hursh, be seated, please.

I suppose that railroad passengers are greatly intrigued by the stories, and some reference has been made to them here, of new developments that will make reservation of pullman space an instantaneous and magic process.

This is all well and good, but we are especially interested in hearing from you about the developments in train switching-yards. One reads articles in the papers about electronic train yards that speed freight and that, by pushing buttons in a tower, operators can gently handle long strings of freight cars by using radar, computers, electronic scales, television cameras, and automatic switches.

We are glad to have you here, Mr. Hursh. You may proceed in your own way, if you desire.

Mr. HURSH. Thank you, Mr. Chairman.

STATEMENT OF S. R. HURSH, CHIEF ENGINEER, PENNSYLVANIA RAILROAD CO.

Mr. HURSH. I am sorry that the scope of this testimony is not such that I can present you with some exhibits, as they are too large.

I have learned from the economist of your subcommittee, Mr. William H. Moore, that it is my function to present testimony and exhibits, if any, that would bear on the implication and significance of automation in classification yards and other related aspects as it may affect or apply to the railroad industry, principally as to the social and economic implication of automation.

Your witness today is at a loss to describe automation in the true sense of the word. The only real automation to my mind is the human heartbeat which is not subject to conscious control of man. Automation, therefore, is nothing more than controlled mechanization whether that control be electronic or mechanical.

The word "automation" is a comparatively new word. It has in a short period of time become a new science that is having a great effect in many industries especially those that lend themselves to automatic control like the chemical and oil industries and the utilities, such as light and power companies.

It is, however, not new to the railroad industry, especially in the field of railway signaling. For years we in the railroad industry and the manufacturers of signaling devices have thought of it as system control engineering and it dates back to the inception or invention of the track circuit as early as 1872. Since that time, steady growth and development of signaling equipment by close collaboration between the railway industry and the makers of signaling equipment, such as Union Switch and Signal, Division of Westinghouse Air Brake Co., and General Railway Signal, there has been developed the following: Centralized traffic control, automatic train control, continuous cab signaling, route interlocking, automatic freight car classification; the latter, of which, I will touch on in detail, by an explanation of what the Pennsylvania Railroad is now constructing at Conway, Pa., 22 miles west of Pittsburgh on our eastern division.

The witness does not want to create the impression that Conway is the only modern classification yard on American railroads. Many other progressive and well-managed roads have done likewise, and others are going forward with similar installations. Typical examples are the new yard of the Seaboard Air Line, at Hamlet, N. C., and the Bensenville and Air Line yards of the Milwaukee road, that your witness visited with other engineering officers of our company to obtain ideas which were most profitable in the design of Conway yard.

Why did the Pennsylvania Railroad Co. decide to make an investment of $34,200,000—$31,262,300 for the Conway yard development and $2,937,700 for related facilities at other and nearby locations, east and west thereof? For the sole purpose of providing better and faster customer service because of the competitive situation, to increase operating efficiency, cut per diem and operating costs and minimize damage to lading.

An exhaustive study was made by a committee assigned by management of our entire train operation and car movements in the entire system. This study, of course, was made to determine what improvements could be made to simplify the handling and expedite the movements of freight cars through terminals. This study determined the desirability of providing two modern car-retarder installations with supporting yard and facilities at Conway, Pa., which is 22 miles west of Pittsburgh on the line between Pittsburgh, Detroit, and Chicago. This location is also easily accessible for trains on the panhandle between Pittsburgh, Columbus, Cincinnati, and St. Louis, and is strategically located to handle all freight moving west of Pittsburgh.

Considering the volume of traffic which would be routed through this new terminal and the possible increase in such traffic, designs were made for 2 retarder classification yards each of which should handle approximately 4,500 cars per day, single count. These yards are identified as Eastward and Westward Conway, and will consist of 54 and 56 classification tracks, respectively, with supporting complement of receiving and advance as well as relay yards, and storage tracks, as well as complete rearrangement of car repair and locomotive facilities.

Route type interlockings at each end of the terminal provide for interlocking consolidations and will facilitate train movements on the main tracks and to and from the yards.

The overall design has resulted in the largest railroad terminal in the world, with capacity provided to handle freight traffic to the best economic advantage and a reasonable reservoir for anticipated growth in the business volume.

The eastward yard has just recently been placed in service September 20, 1955, but the full economic benefits await completion of the westward classification and train-handling facilities.

With fulfillment of the complete plan, the pattern of car classification to be undertaken at Conway will supplant work now performed at many other terminals, with resulting improvement in freight service through the elimination of duplicate handling and classification. In addition to the benefits of improved service—freight movement will be quickened—the cost of classification work will be substantially reduced.

The westward plan calls for tandem receiving and classification yards with a parallel departure or advance-relay yard and is arranged to provide maximum capacity in car classification. The yard is designed with dual humping leads and crossovers below the master regarders to facilitate classification into any track from either lead. It includes a push-button machine with tape storage feeding system for automatic switching located near the apex of the hump and a retarder control machine located in the top floor of the control tower about 800 feet below the apex. From this vantage point the retarder operator will have an excellent view of the entire classification yard and

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will be able to spot quickly, and take the necessary corrective measures, for any emergency situations that may arise.

Mr. Chairman, to the rear of this testimony is a map which shows the layout of this yard, should you desire to follow it.

(The map referred to is available in the committee files.)

Mr. HURSH. It is apparent that to realize the greatest benefit from this new terminal facility the most modern design and apparatus available should be used. The tremendous volume of traffic through Conway can best be handled in an automatic car retarder classification yard, which includes automatic retarder speed control and automatic switching, with teletype tape storage feeding system, as well as other adjuncts enumerated below:

1. Electropneumatic retarders, which are the basic device for car retarder yards.

2. Automatic retarder speed control with automatic operation of all retarders based on the following components:

(*a*) Weight-control system, which classifies cars as between light, medium, and heavy, for automatic operation of the master and intermediate retarders, and is also used in the selection of pressure for the group retarders.

(*b*) Car-rolling-resistance measuring equipment to automatically determine the rolling resistance of each cut in order to predict rollability after leaving the group retarder.

(*c*) Classification track fullness equipment to automatically record cars entering each classification track and to transmit into the electronic computer information on how far each cut most roll, which data is also a factor in the selection of proper leaving speed from the group retarder.

(*d*) Electronic computer, which automatically correlates information supplied by the various sensing devices *a*, *b*, and *c*, and including characteristics of the individual classification track in selecting the proper leaving speed from the group retarder.

3. Electropneumatic switch machines with detector track circuits are used for the power-operated switches in the yard.

4. Automatic switching which provides for automatic positioning of switches and routing of a cut to the desired classification track, including:

(*a*) Teletype tape storage to store route information for an entire train and introduce same automatically into the automatic switching system. In the event change in track designation becomes necessary this can be accomplished by operating pushbuttons which supersede the tape recording.

In addition, a clearance light will be provided on the control panel for each track, so that protective steps may be taken to guard against cornering or sideswiping of cars.

5. Yard-track indicator to indicate to arriving trains which track of the receiving yard should be entered. The indicator is usually controlled from the yardmaster's office or some other appropriate point.

6. Hump and trimmer signals which include both wayside and cab signals to direct the movement of the humping engine.

7. Dragging equipment detectors in advance of the hump to detect dragging equipment which could foul the car retarders and switches. Actuation of this device places the hump signals at stop.

At this point I would like to bring out in connection with the dragging equipment detectors. Mr. Chairman, you undoubtedly noticed between here and New York pieces of equipment, about 1½ to 2 miles in advance of a main track interlocking. That is the dragging equipment detector, so that if there is a brake rigging or brake shoe, or anything hanging from a train, it will actuate the signal in advance of the train and that train will stop. We are applying the same thing here.

8. Shove signals to aid in train make-up on the departure tracks.

The basic elements of the systems used have been proved in service in many installations including Air Line and Bensenville yards on the C. M. St. P. & P. Railroad, Hamlet yard on the S. A. L., Mon Southern yard on the Union Railroad, and most recently our own Eastward Conway yard.

I will now go on with a brief description of each component.

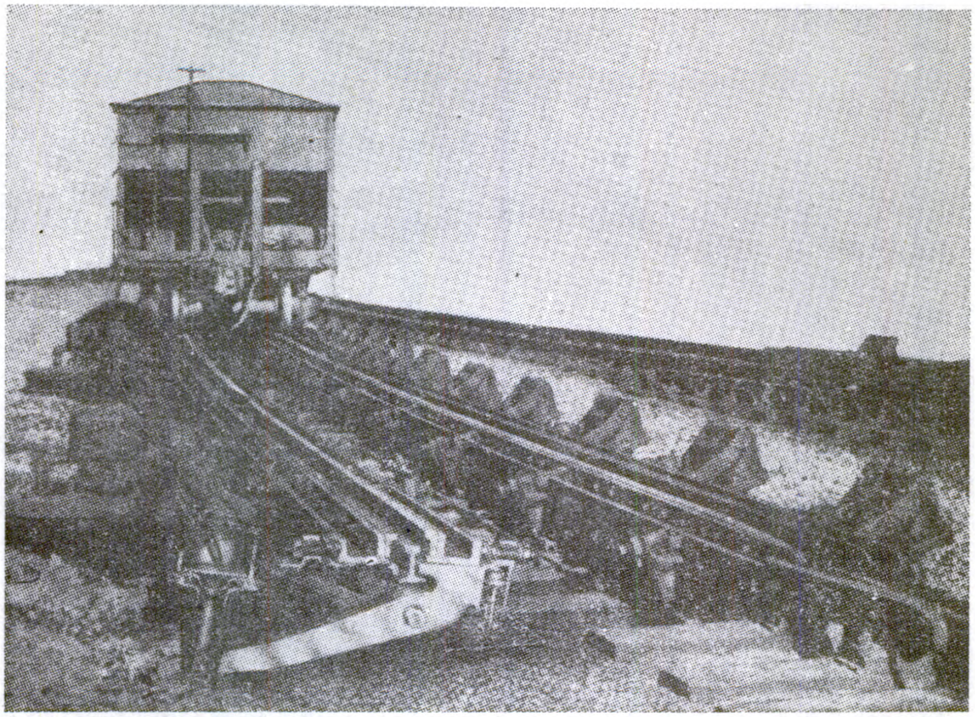
The car retarder is the fundamental control device in a mechanized classification yard, whether controlled manually, semiautomatically, or fully automatically. Electropneumatic car retarders combine instant operation with firm, yet resilient, braking force. The instant response, flexible operation, and accurate control obtained from electropneumatic operation makes the retarder ideal for fully automatic operation as planned for this yard.

Retarders consist of a number of 6 foot 3 inch long units with individual power cylinders. This unit construction permits any number of retarder units to be installed on either rail or on curved track, an important space-saving feature.

Car retarders use compressed air as the source of braking power. The shock-absorbing characteristics of the air in the cylinders cushion the effect of any unevenness of the brake shoes or the wheels so that shocks are not transmitted back to electrical equipment or through mechanical devices.

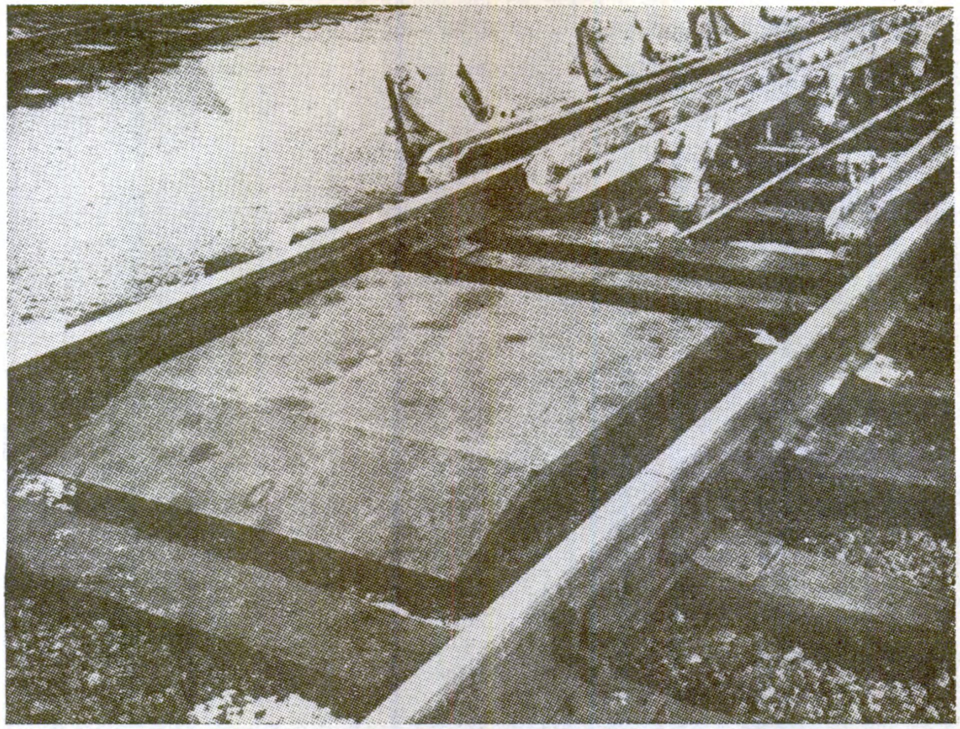
Since the braking is accomplished through the medium of compressed air and the retarder has only one closed position the retarding force is independent of reasonable brake shoe wear and variations in car wheel width.

This photograph depicts a retarder.



Electro-Pneumatic Car Retarder uses air as the source of braking power to apply brake shoes on both sides of car wheels. It is unit-constructed and provides engineering advantages that mean more efficient utilization of yard space.

The automatic speed control system is based on electronic principles and provides automatic control of retarder pressure in order to obtain the desired leaving velocities. The speed of cars as they approach the retarder and while within the retarder is measured by the Union Velac system. This system makes use of radio frequency waves directed toward the moving cars which when reflected produce a Doppler effect. A frequency authorized for this service by the Government is used. The Doppler effect is proportional to the velocity and is therefore a measure of the speed of the cars. The retarder pressures are automatically varied as the cut moves through the retarder in accordance with the rate at which the car velocity is approaching the desired leaving speed. The leaving speed is established by the weight-control system in the case of the master and intermediate retarders and by the electronic computer in the case of the group retarders.



Antenna for UNION VELAC System. Car speeds, as measured by this equipment, are used in combination with the retarder speed control system to obtain proper leaving speeds.

With the afore-mentioned and required equipment available to provide the vital information, the next step toward full automatic control is the addition of an electronic computer. Frequently referred to as an electronic brain, the computer receives its information from the various sensing devices, weight control, rolling resistance, cut length, track fullness, classification track factor, and determines the correct leaving speed from the group retarders so that cars will couple at proper speeds on the classification tracks.

Any combination of information supplied by the sensing devices, A, B, and C, when interpreted and properly correlated will establish a desired leaving speed ranging between two extremes. For example, minimum speed will be called for by a combination of a heavyweight cut with good rolling characteristics traveling to a nearby full tangent track during exceptionally fast or warm weather conditions.

In other words, a car will move more rapidly in warm weather than in cold weather. Conversely, a poor rolling lightweight car traveling under adverse or cold weather conditions to an empty track with curvature will leave the retarder at maximum attainable speed.

The car-weighing device, usually located in advance of the master retarder, is a special 7-foot length of rail of particular design and heat treatment with a small horizontal slot at its midpoint. The deflection of the rail caused by passing car wheels closes 1, 2, or 3 contacts depending on whether the load on the wheel is of light, medium, or heavy classification. If different values are obtained from the four wheels of a car the system treats that car as of medium weight. Correspondingly, if different weights are detected on wheels of a cut of cars the cut is treated as of medium weight cars.

In the case of long retarders, it is possible to have the first cut controlled by its weight independently of the control of a second cut by another section of the same retarder.

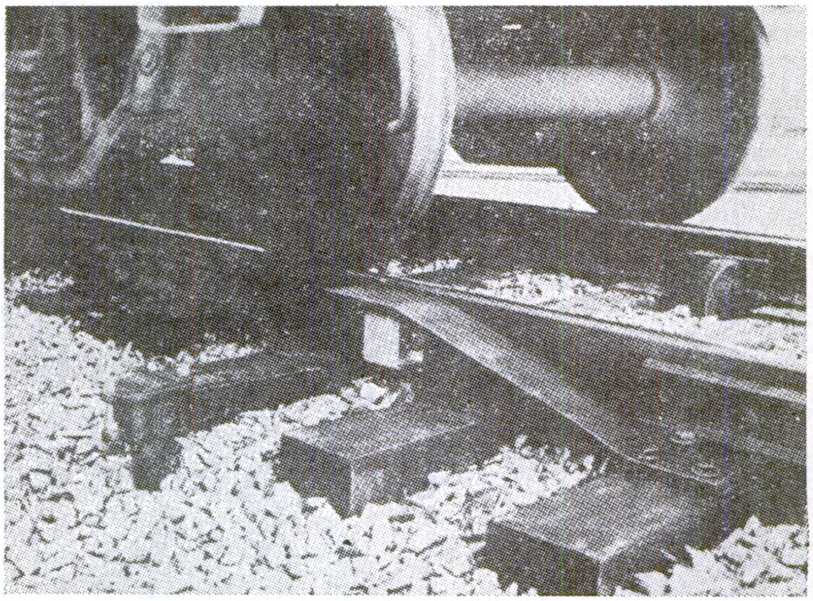
If you are not familiar with what we term a "cut," as the train is pushed to the apex of the hump, a cut may be 1 car, it may be 2, or it may be 5 or 6, depending upon its destination, to go to a particular track. That is what we mean when we refer to a cut of cars.

Mr. MOORE. How high is the hump above the level of the yard?

Mr. HURSH. It is about 40 feet. The grade on the classification tracks is 0.15 of 1 percent.

The weight information secured from this device is used to automatically select the desired leaving speed and desired braking pressure of the master and intermediate retarders so that these retarders operate completely automatically.

The weight information is also transferred to the computer associated with the group or final retarder in the route of the particular cut, where it is evaluated as a factor in the selection of the calculated leaving speed and braking pressure for that cut when passing through the retarder.



As car wheels pass over the Car Weighing Device, weight information is automatically obtained.

One of the most important steps toward complete automation is to automatically determine the rolling resistance of each cut. This is accomplished by determining the rate of change of velocity over a known uniform grade on tangent track and measuring the difference in velocities over a fixed distance and known grades on curved track.

In the first method the measurement of acceleration is accomplished by first measuring the velocity and then determining rate of change of the velocity. Union Velac equipment is used to determine both functions as the cut is passing over the measuring section.

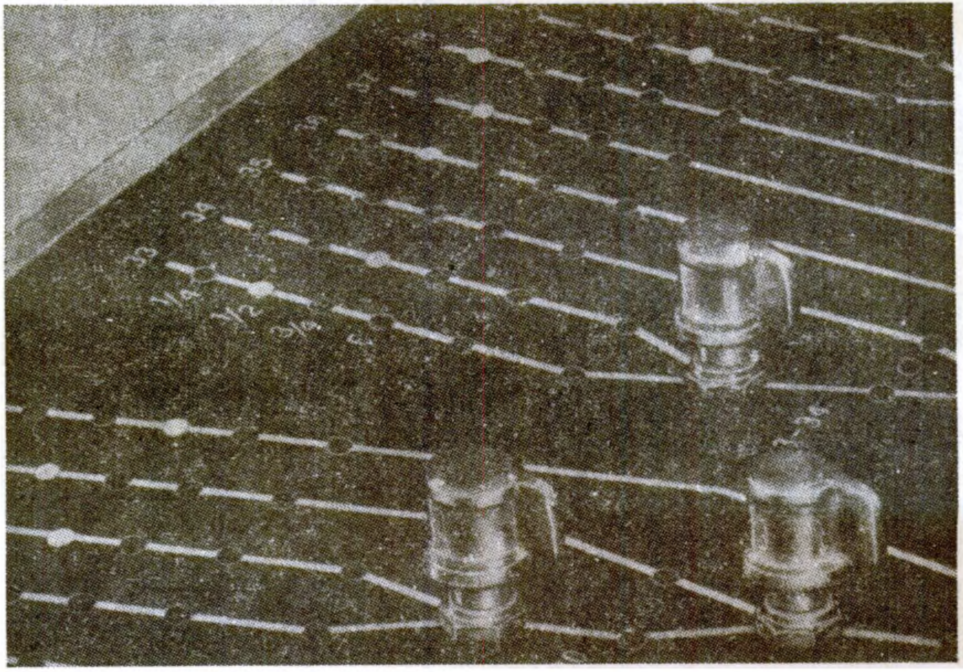
In a fully automatic system, the information received from this electronic equipment is used to predict the behavior of the cut on tangent track and is a vital factor in determining the leaving speed from the group retarder.

The second method to automatically determine rolling resistance on curved track is by comparing a known exit velocity from one retarder to a measured velocity in approach to another retarder. The exit velocity from the upper retarder is obtained through the automatic weight control system. The velocity in approach to the lower retarder is measured by the Union Velac equipment before the cut enters the retarder. Rolling resistance corresponding to the two velocities is computed by an accelerometer. Similar to the previous method, this information in terms of car rolling resistance is used to predict the behavior of the cut on curved track and is likewise a vital factor in determining the leaving speed from the group retarder.

In order to take into consideration the effect of various lengths of cuts on rolling characteristics, the number of cars in the cut is determined by an axle-counting system ahead of the master retarder. This information is transmitted through the automatic switching system to the electronic computer.

We have also in this yard at the far end a track fullness indicator. The track fullness system determines the distance that each car must travel on its designated track. The distance is automatically adjusted for each car that enters each track.

Track fullness lights are placed on the retarder control machine to indicate steps of partial occupancy and full occupancy of the classification tracks. A cancellation-add lever is provided to add or subtract cars which may be added or removed from the classification track by other than the normal humping classification.



Indication lights on Retarder Control panel show that tracks are 1/4, 1/2, 3/4 or fully occupied, or empty.

By that I mean, as a car goes over the hump and the inspector finds it has a defect, it is destined to a particular track. The hump operator will cut that car out and shunt it through a car repair track and not put it on the track it had been destined to, and, therefore, he can step in and by manual control correct the hump fullness indicator.

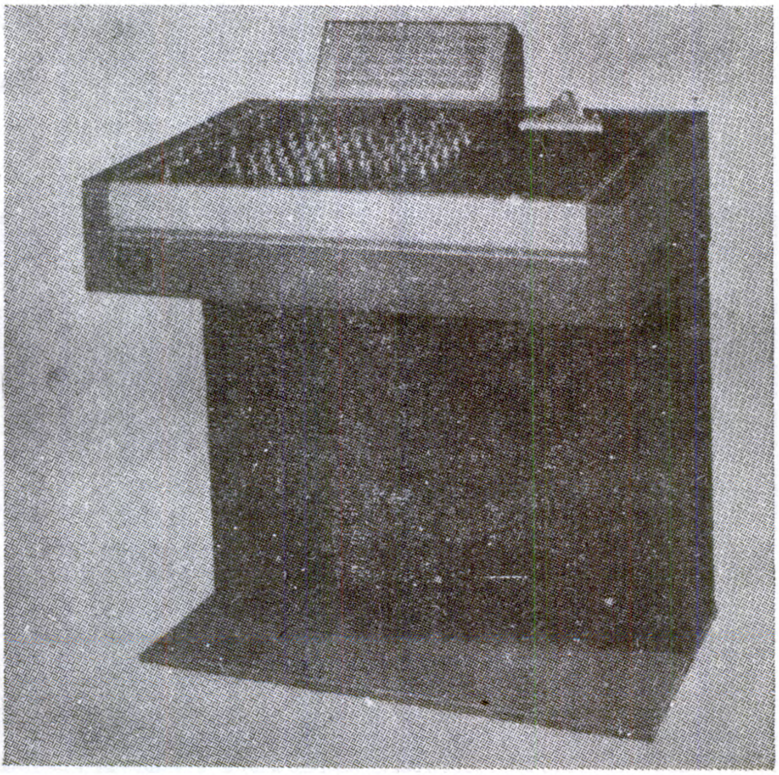
AUTOMATIC SWITCHING SYSTEM

Automatic switching provides for automatic routing of a cut to the desired classification track in accordance with route information which is fed into the system through the teletype tape storage feeding equipment. All switches required to route each cut to its designated track are automatically positioned as the cut advances. Trimming operations are reduced because the possibility of misdirecting cars is lessened.

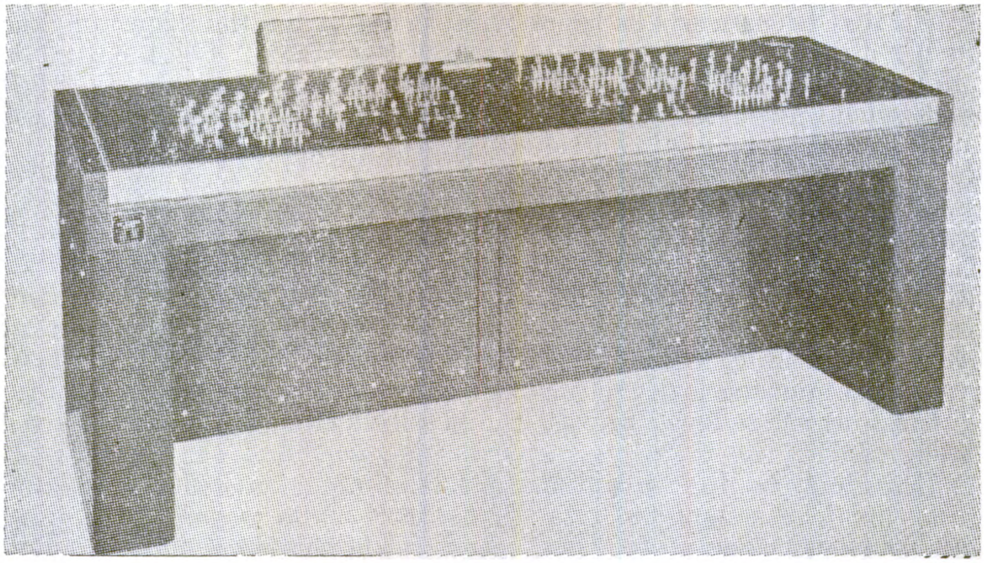
A wide flexibility in automatic switching is provided to permit concentrating switch and retarder controls while retaining the speed and efficiency essential to classification yard operation.

The automatic switching system also serves a vital function in transmitting car weight, car rollability and track fullness information.

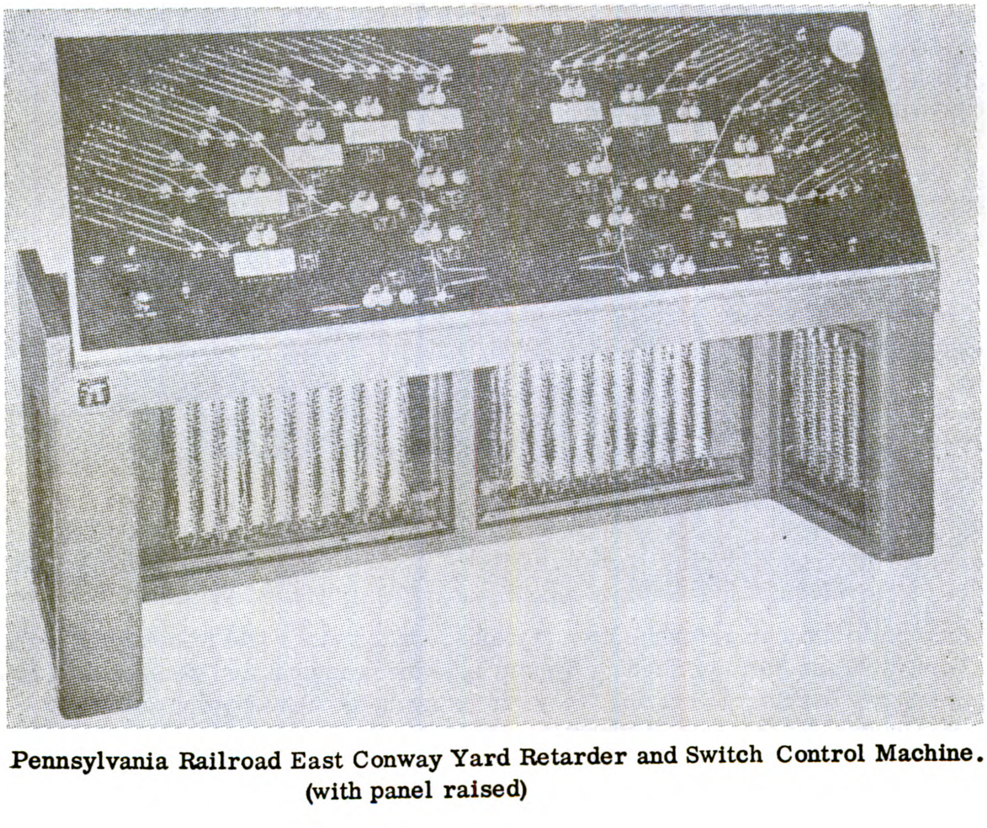
The next three photos are exhibits of the machine in use.



Automatic Switching Push-Button Machine. Automatic route information from Teletype Tape Storage Feeding System appears in indicator. If correction are necessary in this information, they can be made by manually operating the push-button for the proper track.



Retarder and Switch Control Machine is of functional shape, which places indication lights and manual control for retarders and switches in convenient location for the operator. Controls and indication lights are grouped on a miniature track diagram of the classification yard at points representing actual location of the retarders and switches, permitting the operator to assimulate quickly the information portrayed by the indication lights. Indicator at top of control machine displays route information to the retarder operator.



Pennsylvania Railroad East Conway Yard Retarder and Switch Control Machine.
(with panel raised)

TELETYPE TAPE STORAGE FEEDING SYSTEM

A system for automatically routing cars to the proper classification track, this development permits classification of an entire train without the necessity for an operator to push a single route button. It works in the following manner:

A switching list for a string of cars is usually received in the control tower and printed with a conventional teleprinter. As the switching list, which includes various information about each car including the track to which it is to be routed, is being received, the track destination information is automatically and simultaneously punched on a tape by a reperforator, attached to the teleprinter. The reperforator is arranged to cut in when the printer comes to the track number and to perforate this information only.

The tape is fed into a transmitter distributor which searches for and reads the punched holes, and then feeds this destination information in the form of a teletype code, to the decoding unit. The decoding unit translates this code into numbers which are fed into the automatic switching system which sets up the required route automatically.

The teletype system automatically keeps five storages in the initial storage units at all times. The teletype system "stays in step" with cars as they go over the hump because it is so arranged that when one cut goes over the hump, another storage is introduced automatically.

A set of push-buttons, one for each track, is provided for the operator's use in case of emergencies, or to change the destination of cars from that given in the teletype list in case bad-order cars are discovered as the cars approach the hump. In these cases, the operator presses a cancel button to cancel the original destination of the cut when it enters the automatic switching system. This operation also stops the tape system, allowing the operator to manually add the track destination desired. Automatic operation is resumed when the operator pushes a start button. The system can be so arranged that a cut can be rerouted to a specific track, say, a bad-order track or a rehumping track, by pushing but one button.

WAYSIDE SIGNAL SYSTEM

Since two leads are provided over the hump and practically two distinct receiving yards are also provided, two separate but coordinated hump signal systems are provided. As an example. this arrangement permits moves in the south receiving yard to get the next train ready to be classified while humping is proceeding from the north receiving yard.

Union Style R–2 four-indication signals are located at the hump facing the receiving yard. One the same mast are mounted Style R–2 two-indication trimmer signals facing the classification yard. Style R–2 hump repeater signals with units facing both directors are located at appropriate intervals throughout the receiving yard. Style HC–32 trimmer repeater signals are located in the classification yard. The signals will provide the following indications:

Hump signals		Trimmer signals	
Aspect	Indication	Aspect	Indication
Green	Hump fast	Green	Trim.
Yellow	Hump slow	Red	Stop.
Red	Stop		
Flashing red	Back up		

The signals are normally controlled from the hump conductor's office with auxiliary control to place all signals at stop from the retarder tower in the event of emergency. Signal aspects will be indicated at both the hump control machine and the retarder control machine. Also included on both signal control panels is a two-position hump track transfer lever which can be set for either north or south track humping and indications are provided accordingly.

Actuation of the dragging equipment detectors will place the hump signals to stop.

The signal circuits and associated timing apparatus are interlocked to prevent the setting up of unsafe conditions and to provide a fast, flexible system of yard operation.

TYPE "CY" INDUCTIVE CAB SIGNAL SYSTEM

That, Mr. Chairman, you have undoubtedly heard of, cab signals in engines, on our main line, whereby the engineman has about that far in front of him [indicating] the same signal indication that he receives from the wayside signal, whether it is fog or bad weather or not. The same thing we have here.

The Union Type "CY" Inductive Cab Signal System provides—in the cab of the humping locomotives—both a visible and an audible indication of humping instructions. "This "double signal in the cab" keeps enginemen constantly and continuously alert to these instructions.

With this system, up to four locomotives can be controlled simultaneously yet independently over one carrier frequency by simply operating toggle switches, one for each locomotive. Each locomotive can be sent any of four indications: Hump fast, hump slow, back up, or stop. Changes in instructions are instantly announced by a change in cab signal indication and the ringing of a single stroke bell. The result is constant instantaneous control of humping speeds—and regardless of fog, smoke, snow, or any other adverse visibility condition.

Cab signal control is transmitted from wayside to locomotives by inductive coupling between a modulated carrier current and rugged, weatherproof coil mounted on the locomotive. The modulated carrier is transmitted over an elevated wire on a pile line running parallel to the tracks.

Office equipment consists of a power supply unit, an audio oscillator unit and a carrier modulator unit, all of which are mounted on a standard communications rack. Output of the carrier modulator is fed to the line through a coupling unit which blocks other communication frequencies which might be on the line.

Power for the equipment is supplied directly from the locomotive battery—thus obviating the need for a motor-generator set.

DRAGGING EQUIPMENT DETECTORS

A self-restoring dragging equipment detector is installed on each of three leads approaching the hump. These devices detect defective equipment on cars such as brake rigging, etc., that comes within 3 inches of top of rail and are circuited to place the hump signal to "stop" and to provide visual and audible alarms at the hump office, at the control tower, and at the inspection pits. A pushbutton for silencing the alarm and resetting the dragging equipment detector stick relays is provided on the hump office machine.

SHOVE SIGNALS

Shove signals assist in making up trains in the departure or advance and relay yard. Since the distance between the yard engine and the head end of a cut may be quite long, these signals inform the engineman of the location of the head end of his cut with respect to the clearance point on the departure tracks.

Subway-type light signals are proposed for this purpose. These signals are equipped with two roundels which face in opposite directions.

A track circuit of appropriate length is provided on each departure track. With the track circuit unoccupied, an indication will be displayed. When the track section is occupied the signal will be dark. The yard engine will then back up until the signal again lights. This insures sufficient track space at the opposite end of the train to couple a road engine without fouling adjacent tracks. Your witness has endeavored in the foregoing description of Conway yard to tell you in as brief a manner as possible what we have installed and intend to install at Conway, which when completed will be the largest freight classification yard in this country, in fact, the largest of any country.

The question may well be asked by any member of this honorable committee, what other yards do you have that are operated by retarders and where located. The answer is—both the eastward and westward yards at Enola, located on the south side of the Susquehanna River opposite Harrisburg, Pa., are car-retarder yards.

The eastward yard had been in operation for some years prior to World War II and proved such a successful operation with respect to efficiency. During the war, because of a serious shortage in trainmen for operating not only road trains but yards as well, management authorized the expenditure of $1,600,000 to put manual control retarders in the westward yard in 1944. That was prior to the advent of so-called automation, or the adoption of it.

This yard consists of 36 classification tracks having 1,548 track feet of retarders with 44 switches controlled manually from 3 retarder towers. This greatly relieved the manpower situation by permitting us to obtain the services of 130 trainmen for use on road trains, both local and through, as well as for other needy yard services.

This installation greatly relieved the congestion in other yards, both east and west, and helped to correct a serious car shortage at that time.

The success of and the efficiency obtained by the installation of manually controlled retarders in the westward yard at Enola, prompted management to authorize the money required to install retarders in the westward yard at Pitcairn, located just east of Pittsburgh on our Pittsburgh division, in the year 1946.

This yard consists of 41 classification tracks having 1,236 track feet of manually controlled retarders with 43 switches controlled manually from 3 towers.

The foregoing explanation as to what we have installed and will install at Conway to complete this modern yard had to be of necessity rather technical. Some of you who may be familiar with railroading I feel have had little trouble in understanding the function of a modern retarder yard. There may be others present, however, and it is quite understandable, that are asking, "How does this modern yard work? How does it function?" For them I will endeavor to give a brief description as to what takes place in actual operation.

Freight trains are received at either the west or east end of Conway and directed to a track in the receiving ward via route signaling. As trains enter the receiving yard, the cars in the train are checked and numbers telephoned to the yard office, where a recording of the car check is made. This check of train consist insures that the hump switching list is made up in proper order.

On arrival of each train in the receiving yard, the trains is subject to inspection and journal box lids opened for oiling. Defects in cars are relayed by radio (walkie-talkie) to the yardmaster and bill clerk, which enables the switching of defective cars to a shop track during the humping operation. As the train is inspected, a pusher engine is placed on the rear of the train and upon direction of the hump conductor, the humping operation, which involves placing each car on the proper classification track, begins. As cars are approaching the apex of the hump, the journal boxes are lubricated.

In accordance with the switching list prepared in the yard office and transmitted to the hump, the hump conductor selects the desired classification track for each car, or cut of cars, according to destination, and directs the separation of the train into proper blocks. The hump conductor is provided with a panel consisting of a group of buttons, numerically identified for each classification track, on which he selects the proper track for each cut of cars. He can select as many as five classification track designations at one time. Normally, a teletype punched tape is made with the switching list which permits the entire train to be classified without the hump conductor taking any action on the switching panel.

This operation is called fully automatic classification. As cars progress over the hump toward the classification track, the track switches are automatically positioned for the desired track.

In the elevated structure near the apex of the hump, the retarder operator sits before a desk-type panel, consisting of manual control devices, which supersede automatic devices in the control of switches and retarders as may be required in the event of an emergency.

Before both the retarder operator and hump conductor there is a numerical indicator panel showing routes of each car, or cuts of cars, as they progress over the hump to the classification track. As cars move over the apex of the hump, the destination of successive cars is shown automatically on this panel.

The retarders are equipped with automatic speed control, the object of which is to permit cars, or cuts of cars, to enter the desired classification track at the right speed and couple to cars on that track without damage. This requires the use of several "sensing" devices which detect weight of cars, speed through retarders, car rolling resistance and distance car must travel on the designated classification track.

The speed at which a car, or cut of cars, leaves the first or second retarder is selected automatically by the automatic car weighing device, and checked by the radar speed detecting equipment.

The automatic weighing device is installed between the apex of the hump and the first retarder, weighing all cars, regardless of the number of cars in the cut and classifying each cut as heavy, medium, or light in weight. Braking action in the first two retarders is then controlled automatically, and radar speed checking is employed to insure that the proper speed out of these retarders is obtained automatically.

Car rolling resistance on tangent and curved track is also determined by radar equipment automatically on known grades and degree of curvature, by a measure of speed and acceleration as the car moves over the grade or curve.

Each classification track is provided with a track fullness indication to show whether the classification track is empty, one-fourth, one-half, three-quarter, or fully occupied.

As a car progresses over the hump the weight, rolling resistance, and track fullness, along with the length of the cut, and a classification track factor, is coördinated in an electronic computer to determine the speed of the car out of the final retarder entering the designated classification track.

This information combined and correlated by the computer, is used to automatically govern the final retarder so that cars, or cut of cars, leave the final retarder at the right speed to couple to the other cars on the designated classification track without damage.

As the cars are classified on the classification tracks, they will be pulled to the advance yard, where departing trains are made up into complete road trains for distant points, and from which they are dispatched to main tracks via interlockings.

The foregoing should enlighten your honorable committee with respect to the functnoning of a large modern classification yard, where all the electronic features that are known to be of practical value are used to achieve as near automation as possible.

What other systems of so-called automatic control do we have as efficient means of operating trains safely on our railroads? One of the oldest is centralized traffic control commonly known in railroad language as CTC.

CENTRALIZED TRAFFIC CONTROL

The operation of trains in both directions on a single track by signal indication was originally limited to locations where it was possible to arrange for cooperative and positive action between two adjacent open block offices.

Beginning in 1927, a coordinated system of train operation on a single track by signal indication was devised coordinating several locations from one control point and was named centralized traffic control.

On the Pennsylvania Railroad there are 9 installations of centralized traffic control on single track, over which trains are operated by signal indication in both directions. These installations involve 430 miles of track and 380 miles of road. The total cost of the 9 projects was approximately $3,165,000 averaging $7,355 per mile of track and $8,331 per mile of road.

To the 9 projects on single track additional facilities were added and utilized so that on these 9 projects there are 85 interlocking plants now coordinated by centralized traffic control.

It was soon realized that centralized traffic control was a convenient method of remotely controlling interlocking plants on a multiple-track railroad. We have, therefore, on the Pennsylvania Railroad 76 interlocking plants in multiple-track territory controlled remotely by centralized traffic control.

In addition to the operation of 430 miles of track operated by signal indication in both directions on single track, there are also 624 miles of track in multiple-track territory operated in both directions by signal indication. Some of the multiple-track territory is a coordination of adjacent offices, and some the coordination of several interlocking plants by centralized traffic control.

There are, therefore, 1,054 miles of track on the Pennsylvania Railroad operated by signal indication in both directions, 559 miles controlled by centralized traffic control and 495 miles of reverse signaling controlled by the coordination of adjacent offices.

CONCLUSION

It is reasonable to expect that the honorable chairman and the members of the Subcommittee on Economic Stabilization desire an expression of opinion from the witness as to how many more installations will be made of like character on our railroad, or what may be expected on other railroads in the transportation industry.

First, permit me to say that what is hereafter said as applying to the Pennsylvania Railroad will, I am sure, apply in like manner to any other class I railroad.

In considering the application of automation or controlled mechanization, the whole theme or point of view is "Emphasis of efficiency." Unless you expect to get increased efficiency in whatever field you desire to use automation, there is no use making the investment. There is no use, nor should consideration be given to any project unless the economics prove it worthwhile, otherwise we cannot hope to survive. Further, and I cannot too strongly point out—it is only possible to achieve the utmost in automation where continuous process production is the type utilized. Classification of cars in large yards on railroads is such, and one of the few fields where it can be economical in the transportation industry, as a result, it can be readily observed the matter of true automation in the transportation industry is thus limited.

To date studies on our railroad have indicated that so-called automation with all its aspects cannot be justified with light volume of traffic. However, this pattern can change quickly, due to the con-

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tinuing rise in wage and material costs. As a result, we do not think any definite criteria can be advanced at this time as to just where we would be justified in applying automation to a classification yard. Our thinking as of this time indicates a volume of 1,500 to 2,000 cars each 24 hours is required to prove the justification for the expenditure involved.

As to the social and economic effect upon our employees or the employees of any other railroad in the industry, no serious concern may be anticipated adversely to the employees. If what is done leads to more efficiency and more economy to the industry as a whole or an individual railroad, it makes more secure the employment of all employees.

The CHAIRMAN. Thank you very kindly, sir.

I do not want to take the time to ask some questions I had in mind, but I would like the privilege of submitting the questions to you so you can answer them and return them along with your testimony when it is submitted to you, if that is all right.

Mr. HURSH. I will be very glad to.

The CHAIRMAN. Possibly the staff would like to ask you some questions now.

Mr. MOORE. I won't take but a minute, Mr. Chairman.

One of the things I was going to say isn't perhaps a question, as much as an observation. It has sometimes been said that American railroads are not progressive or are lagging in the acceptance of modern methods. Those who read or have heard Mr. Hursh's statement, while they may not understand it very well, will I think have to reexamine this charge as to the lack of progressiveness.

The one question I did want to ask you, it was stated in the Wall Street Journal on June 29 that this Conway yard cost about $34 million, and is expected that it will eventually pare operating expenses about $11 million a year. What are the sources of those savings? Can you break that $11 million down, if possible, into laborsaving or savings on damage claims or speedup, or what not?

Mr. HURSH. The last two you indicate are the factors, speedup and damage claim. The speedup will be savings in per diem.

Mr. MOORE. Of the $11 million, how much might be due to speed-up.

Mr. HURSH. Quickness of operation. It permits of sending a train from the east to Conway, destined Chicago or St. Louis or Detroit, as a train without prior classification in the eastern seaboard, and Conway can classify for individual industries, we will say, in Chicago—for instance, Chicago as a railroad center, we all know it is very large. There are so many railroads that about the largest cut that any shifting locomotive may have, or group of cars, is 20 to 25. If he has any more than that, he is blocking our neighbor, so that it is a very expensive operation in Chicago to classify cars for industry.

At Conway, we will be able to classify westbound trains by industry. It will speed up to the extent that rather than hand operation, we can handle, push over this hump and classify approximately 130 to 140 cars an hour. Now, when I say an hour, it will actually not take an hour to do the work. We could do the work in about 40 minutes, but the elapsed time between the 40 and the 60 minutes is lost time by the hump engine going and getting another train to push it over. It is the speedup, the saving in per diem. We estimate that for the number of cars handled on our railroad, if we increase the availability of cars or reduce the standing time by 10 to 11 minutes, it is equivalent to about 13,000 cars in a year, so anything that we can do to speed up that movement, instead of having them standing around in yards, is the biggest factor, and the statement that you quoted from the Wall Street Journal is, I will say, correct.

Mr. MOORE. If you could speed up the movement of cars 10 percent, it would be equivalent to building another 10 percent of the car stock?

Mr. HURSH. I believe even more than that. Somewhere near that figure, when we requested this authority, and it is going to work out, when we get it done. We will not get the saving until the entire yard is complete, but we figured around 30 to 31 percent saving.

Mr. MOORE. One other question that is not related to automation, but when was the principle or the know-how of a hump yard introduced? That must at the time have been a great step forward in railroading, perhaps as revolutionary as some of these other more recent things.

Mr. HURSH. Before my time, before I started in the railroad. When I started, we had hump yards by hand operation. There are some places that we have hump yards that we have found now it is not economical to have them; we had better go to flat switching.

The CHAIRMAN. Mr. Ensley?

Mr. ENSLEY. Mr. Chairman, I would like to study over the witness' statement carefully in the next day or so, and perhaps prepare some few questions which he, on behalf of the industry, could answer when he returns his edited transcript.

Mr. HURSH. I would be very glad to.

The CHAIRMAN. Will that be satisfactory to you?

Mr. HURSH. Certainly.

(The following was later supplied for the record:)

ANSWERS TO QUESTIONS LATER PROPOUNDED BY MR. GROVER W. ENSLEY, STAFF DIRECTOR, TO S. R. HURSH, CHIEF ENGINEER, PENNSYLVANIA RAILROAD CO.

Question 1. Could you provide the subcommittee with a statement covering the handling of displaced personnel, if any, arising from the discontinuance of switching at some yards and terminals due to the opening of the new Conway yard? At other locations where new facilities are being established or planned?

Answer. At the present writing Conway yard is not completed in its entirety—only the eastbound portion is in service. As a result very little, if any, displacement has taken place. In fact, a majority of the personnel have been absorbed in yard crews and those that have not been absorbed in yard crews have seniority in adjacent territory or other yards. Further, at no point in this territory do we now have 100 percent manpower in the transportation department.

Question 2. Do you expect the Pennsylvania to increase its share of intercity freight traffic as a result of more expeditious handling of freight traffic due to new technological development such as automation of freight yards?

Answer. It certainly was the aim and hope that we would obtain increased volume provided we expedite the service, thereby giving better service to our patrons.

Question 3. If this proves to be the case, will this cause any qualification of the opinion now held that automation cannot be introduced in many cases where freight volume is light?

Answer. No. A light volume of freight in any yard precludes the expenditure of money required to effect so-called automation or a retarder yard.

Question 4. To what extent if any have labor costs been a factor in spurring the introduction of automated freight yards? What has been the trend in labor costs per unit of ton-miles of freight handled on the Pennsylvania?

Answer. The continued increase in labor costs has been one of the major factors prompting management to introduce retarder yards. The payroll costs per 1,000 trailing gross ton-miles from 1939 to and including 1954, using 1939 as the index equal to 100 percent, is as indicated below:

Year	Payroll costs per 1,000 trailing gross ton-miles	Index, year 1939=100 percent	Year	Payroll costs per 1,000 trailing gross ton-miles	Index, year 1939=100 percent
1939	$1.79	100.0	1947	$3.12	174.3
1940	1.76	98.3	1948	3.37	188.3
1941	1.84	102.8	1949	3.57	199.4
1942	1.91	106.7	1950	3.78	211.2
1943	2.20	122.9	1951	4.10	229.1
1944	2.35	131.3	1952	4.23	236.3
1945	2.55	142.5	1953	4.22	236.0
1946	2.97	165.9	1954	3.98	222.3

Question 5. What limitations does the Pennsylvania have with respect to the age qualifications of newly hired yard and train service employees? What factors enter into the setting of such limits if they exist?

Answer. The prescribed age limits, except as otherwise noted, for all classes of employees are 18 to 44 years, inclusive. The exceptions with respect to certain yard and train service employees are: Passenger brakemen, 18 to 25; road and yard firemen, 18 to 35.

The maximum age for new employes of 44 years has existed for approximately 50 years. It is believed that, considering the nature of railroad operations, an age limit of this kind is in the interest of the public and the employes themselves.

For passenger trainmen and firemen a lower maximum age has been established because experience has shown that younger men are necessary in these occupations. In passenger service a good appearance is essential and a long period of training is usual before promotion to passenger conductor. Likewise, firemen are usually in service a number of years before promotion to engineer and it is believed they will be better engineers if promoted before reaching an advanced age.

There is no age limit for returning furloughed employes to our service.

Question 6. Does the Pennsylvania have any retraining or relocating program for its displaced employees? What provisions are there for severance pay?

Answer. As indicated in the answer to question No. 7 below, employees who are furloughed from one district of the carrier are given an opportunity for employment on other districts before persons are hired from the outside. This is also true with respect to persons of one craft or class who are furloughed and who are given an opportunity for employment in a different craft or class if there is a need for additional employees in the latter. However, there are provisions in a number of collectively bargained agreements which provide that if seniority is obtained in a different class or craft from that in which the man first obtained seniority, then seniority in his first craft is forfeited. There are also provisions in other agreements to the effect that if seniority is obtained in a second craft, and the employee fails to accept a recall to service in that class, he loses such seniority. Provisions of this kind have a practical effect in many cases of making employment in a different craft undesirable from the employee's point of view.

There have been many occasions when men furloughed from one craft of employees on the Pennsylvania have accepted employment in another craft and have, of course, received the training necessary to perform the duties of the latter.

There is no provision for severance pay as such in effect with this company. However, special agreements are made with unions from time to time to take care of unusual situations involving reductions in force. The Railroad Unemployment Insurance Act provides unemployment benefits of a maximum of $8.50 a day for 130 days. This unemployment compensation is paid for solely by the carriers. There is also an agreement in effect with most of the labor unions and the class I railroads providing protection for employees affected by coordinations, consolidations, unifications, etc., between two railroads. The Interstate Commerce Commission in abandonment proceedings almost universally provides the same type of protection by order under the Interstate Commerce Act.

Question 7. Have there been instances where the Pennsylvania has experienced a shortage of employees in certain classes or crafts at one of its points while employees of the same class or craft were on furlough or unemployed at another point? What is the practice of the carrier in such cases? Are new employees taken on temporarily or permanently, or is there an effort made to draw upon unemployed persons at the other locations?

Answer. There have been numerous instances where a shortage of employees in a certain craft or class existed at one point on this railroad while employees of the same class or craft were furloughed at another point.

There are provisions in several agreements with the labor organizations representing our employees to the effect that persons furloughed in one seniority district shall be given preference in their class or craft on other seniority districts, before new employees are taken into the service.

This practice is not confined to those groups alone where agreements exist. In all crafts and classes the same practice is followed, that is, before new employees are taken into the service, qualified furloughed employees from other districts are canvassed and offered employment.

Our experience under recent favorable business conditions has been, however, that very few furloughed employees will accept positions in their class or craft in other districts except where the employment offered is relatively near to their former places of employment or residence.

Question 8. Have there been situations such as that described above involving the Pennsylvania and another carrier? In such cases what would the Pennsylvanian Railroad's policy be toward taking on unemployed railroad men from another carrier?

Answer. It is possible, of course, that the Pennsylvania may have experienced a shortage of employees of a certain craft or class while some employees of that craft or class are on furlough from some other railroad in the United States. We have no specific knowledge of any such instance. Generally speaking, it is not likely to occur because of the fact that traffic and other conditions which affect the volume of employment on one railroad will have relatively the same effect on other railroads in the same territory. The normal situation, therefore, is that when there is a shortage of employees of a given craft or class on the Pennsylvania there is also a shortage on other railroads in the eastern territory and, likewise, when employees are on furlough from the Pennsylvania there are similar employees on furlough on other eastern railroads.

In any event, as explained more fully under paragraph 9 below, the employment service conducted by the Railroad Retirement Board under the Federal Railroad Unemployment Act provides a means whereby a railroad having a need for employees of a particular craft or class may recruit such employees from persons furloughed by other railroads who are receiving unemployment compensation. Where the Pennsylvania has need for employees of a particular craft or class, and after it has recalled to service any persons in that craft or class who may have been furloughed from the Pennsylvania, and there are available unemployed persons from another carrier who meet the necessary qualifications for service with this company, it is the policy of the Pennsylvania to employ such persons.

Question 9. Would there be any advantage in working out a formal agreement for pooling the railroad work force? Would there be any disadvantages?

Answer. The phrase "pooling the railroad work force" is not entirely clear. If the phrase is intended to imply a consolidation or pooling of all railroad employees in the various crafts so that such employees would have the right to move from one railroad to another in the exercise of seniority when displaced from employment on the former, then, in our opinion, there not only would be no advantage but, as a practical matter, such an arrangement would be almost impossible of accomplishment. Railroad employees almost universally possess elaborate seniority rights to work on a particular part of a railroad by virtue of collectively bargained labor agreements. As a practical matter it would not be possible to permit an employee of X railroad who is furloughed to displace a younger employee on Y railroad where the former has never worked. Furthermore, the difference in working conditions provided by agreement from one railroad to another, the difference in necessary qualifications in some instances due to different operating conditions, the disruption of service and personnel which would result from such moves, the necessity for engine and train service employees to be qualified on all physical and operating conditions in the territory over which they run, and many other practical obstacles would prevent any such wholesale pooling of forces.

If the phrase "pooling the railroad work force" is intended to refer to an arrangement whereby employees furloughed from one railroad may have an opportunity for employment on another railroad that has a need for additional employees, there is already such an arrangement in effect through the operation of the employment service conducted by the Railroad Retirement Board in connection with the administration of the Federal Railroad Unemployment Insurance Act. Railroad employees who become unemployed and who are thus entitled to unemployment compensation under the act are required to register with the employment service. Any railroad which has a need for additional employees may so notify the service which in turn notifies appropriate registrants of the employment opportunity. The Pennsylvania makes use of this service when additional employees are necessary.

Question 10. What prospects are there for the extension of advanced mechanization or automation to the train service? Would this help increase the carrier's share of intercity passenger traffic?

Answer. Prospects for extension of advanced mechanization or automation in passenger-train service are applicable at this time to signaling, communications, improved equipment, and equipment servicing. If and when such improvements come about, it is our opinion that the carriers would be enabled to improve their share of intercity passenger traffic to the extent that:

(*a*) Reduced costs resulting from these improvements can be passed along to users in the form of reduced fares.

(*b*) Reduced elapsed time in transit can be made possible by higher average speeds within maximum speed limits.

Question 11. Does the Pennsylvania expect that a reduction in the average length of the workweek in industry will lead to a greater increase in passenger travel? Are the railroads planning ahead to capitalize on the expected increase in the use of leisure time for recreation, travel, and cultural activities?

Answer. Generally no. Insofar as the reduced workweek in industry leading to a greater increase in passenger travel is concerned, the experience of the Pennsylvania has been that the reduced workweek has reduced passenger travel since it permits greater use of private automobiles. However, should there be a trend toward greater use of our improved passenger service because of any reason, you may rest assured we will quickly avail ourselves of all possible aid to capitalize on the increased business.

Question 12. What effect will the more expeditious handling of freight cars by automating freight yards have upon the demand for freight cars by the railroads?

Answer. The fact that automation in freight yards will make it possible to provide improved service from the shipper to consignee, this improved service will reduce the number of cars that will be required compared with present methods. The number of cars that would be saved or made available would depend, of course, on the current volume of business in all industry.

Question 13. Is there any evidence that railroad employees displaced by technological developments are leaving the industry and being absorbed elsewhere in expanding industries? What has the experience of the Pennsylvania Railroad been in this connection?

Answer. The Pennsylvania has no specific information concerning the extent to which employees who may have been displaced by technological developments have been absorbed elsewhere in expanding industries.

However, Department of Labor statistics concerning employment in the country as a whole seem to indicate that such absorption is taking place.

It is suggested that the committee may be able to obtain further information on this subject from the Railroad Retirement Board.

The CHAIRMAN. We have a mighty fine colleague who spent a lifetime with the Pennsylvania Railroad, Jimmy Van Zandt. He is a very fine Member of Congress, highly regarded. I personally knew him many, many years before he became a Member of Congress.

Mr. HURSH. We think a lot of Jimmy.

The CHAIRMAN. Thank you very much for your testimony.

Without objection, the committee will stand in recess until 2 o'clock this afternoon in this chamber.

(Whereupon, at 11:35 a. m., the subcommittee recessed to 2 p. m.)

AFTERNOON SESSION

The CHAIRMAN. The subcommittee will please come to order.

We had expected to have with us this afternoon on the agenda Mr. John I. Snyder, Jr., president and chairman of the board of United States Industries, Inc. Mr. Snyder's company is the present contract operator of the Rockford Ordnance Plant, which is frequently referred to in automation literature and was mentioned here the other day by Mr. Barton of W. F. & John Barnes. The United States Industries is engaged in a variety of activities in the metalworking and tool industries.

Mr. Snyder has agreed to submit for the record a statement on automation as view in his company, and to appraise also the contributions and problems which the wartime ordnance plant has presented.

The statement will be made a part of the record.

(The statement of Mr. John I. Snyder, Jr., is as follows:)

AUTOMATION AND ITS ECONOMIC AND SOCIAL IMPLICATIONS

Statement by John I. Snyder, Jr., chairman of the board and president, United States Industries, Inc.

At the outset I wish to express gratification that this committee should address itself to a matter of such growing importance to the welfare of our Nation as this development designated automation. I further wish to express my appreciation that this committee should seek the views of all segments of the community—of management and labor alike, of those concerned with the broader implications of automation as well as those engaged in its day-to-day applicatoin in industry.

My own association with automation stems from two specific sources:

(1) Clearing Machine Corp., a division of United States Industries, Inc., is engaged in the manufacture of a full line of industrial presses, machines which are expressly adaptable for automation and are currently in use in automated industrial processes in many of the large mass production enterprises of the country.

(2) My company, United States Industries, Inc., has for the last several years been privileged by the Government to act as operating agent of a deefnse plant located at Rockford, Ill., the Rockford Ordnance Plant. This Government-owned facility, devoted to the manufacture of artillery shells on an automatic production basis, was conceived as a pioneering innovation in automation—it being the first Government plant constructed expressly for the purpose of determining how far complete automation concepts could be utilized in shell production. Is has been serving the dual purpose of manufacturing shells on the one hand while operating as a pilot plant, as it were, on the other.

Thus, I have been in a position to observe the impact of automation in two different fields—one involving the manufacture of machines which are being used in generally automated industrial production and the other, automated production of military materiel.

(In accordance with the suggestion of the committee, I herewith enclose case studies of these two operations of ours, i. e., the Clearing Machine Corp. and the Rockford Ordnance Plant, which I attach to this statement, marked, respectfully, "Exhibits A and B.")

More broadly, though, looking at the entire scene from the viewpoint of a management executive with a close interest in business economics, I have been reflecting upon the whole phenomenon of automation and its potential for affecting our daily living as well as our national industrial development.

From these reflections, it would seem to me that it would be foolhardy and unrealistic to object to the fact of automation as such; for after all, "automation" may be a new word but it is not a new concept. Actually, as the committee so well knows, it is but a stepped-up development of what has been going on from the beginning of the industrial revolution—the application of scientific thought to industrial mechanization in order to lighten man's labors.

Certainly the application of automation to the manufacture of military defense products is absolutely unassailable from any quarter. No right-thinking person could object, for instance, to the unceasing efforts of the United States Government to make better shells—quicker and cheaper—or to any other effort on the part of the Government to find methods for improving productivity in the manufacture of defense materiel in general. For the application of automation in this area is an attempt to better assure the national defense, to help give the taxpayer the full dollar's worth of defense for his defense dollar, and to conserve manpower if necessary in time of war, when manpower can become scarce and national survival the basic issue.

It is of paramount importance to encourage rather than discourage our constant national drive in the area of industrial creativity for the national defense. Especially would it prove dangerous to limit automation in face of the present international political situation. The enemies of freedom can continuously improve their industrial processes at will, in secret and without interference. They can thereby conceivably accelerate their productivity to the point where if we do not remain technologically alert, they might seriously menace our ascendancy. Since we in the United States have relatively much smaller manpower than some of the large countries alined against freedom, it seems clear that only by the maintenance of our overwhelming preponderance in productivity can we retain our dominance.

But aside from this defense consideration, and looking at the matter from the viewpoint of our economy as a whole, it is indisputable that America's present high standard of living—the highest any nation has ever had—has been achieved precisely because we have been dedicated with enthusiasm to constantly improving our industrial processes and correspondingly increasing our consumer demand.

The past has proved this. In the long run every new technological advance, despite dire predictions, has invariably created more jobs rather than unemployment, has created new plants and new industries, and has made for greater consumption and greater prosperity. Thus under our free institutions increased productivity has been absorbed, and production and distribution have ultimately established themselves on an even keel to the enhancement of better living standards for all.

To fetter this process of constant industrial acceleration, it seems clear, would be to strike at the very core of our national well-being.

Of course, facing the matter realistically, it cannot be disputed that such an accelerated technological advance as automation, in the course of bringing far-reaching advantages to the Nation can also bring some serious transition problems in its wake. Certainly there is the possibility of serious unemployment dislocations during the process of adjustment. These, however, should be recognized for what they are—short-term difficulties which will not apply in the long run.

I would like to dwell on this point for a moment. It has been established, I think, by all the testimony heard by this subcommittee to date, that in the long run the development called automation will benefit the Nation in every way. This point has been constantly repeated here. Even automation's most vigorous critics have taken especial pains to emphasize that it is not automation as such that gives them concern, but rather the effects that they feel automation might have if it gets out of hand—as they feel it might without adoption of some one or other of the particular measures they advocate. They are worried, in short, particularly about what will happen during the interim period of changeover to automation. Let us examine, then, what is likely to happen during this interim period.

It must first be recognized that the drive toward full automation is not and cannot be nearly so rapid nor simultaneous in all industry as some would seem to believe. Managements do not and cannot automatize entire facilities overnight. Broad economic considerations, together with all the other factors influencing the decision-making process, militate against the possibility of abrupt changes such as complete simultaneous large-scale automation would entail. For instance, there are factors of changing consumer tastes and changing markets, the fears that new methods of manufacture may render present processes obsolete—together with the question of abandoning large-scale investments. All of these must be carefully calculated and weighed before any such radical production change as complete automation can be introduced into any plant.

Even after the decision has been made to introduce complete automation into an industrial process, the changeover will proceed by stages. It is necessary first to automate one series of operations, then to learn from operating experience, and finally to redesign as necessary. Thus "automation" is accomplished, in any plant, progressively—by degrees as each series of operations is automated. The final step is connecting these automated series of operations together into one automation process. The procedure thus is evolutionary rather than revolutionary.

Thus it would seem clear—when we view entire industries and then individual companies within these industries, all facing an important decision under different conditions—that while in one area the climate may be considered propitious for automation at any one particular time, in others at that time it will not.

This does not mean however that in the individual situations where automation equipment may be installed, temporary pockets of unemployment will not be created as conventional machines are rendered obsosete and new machinery installed. It seems to me that this vexatious possibility, whether due to actual lay-offs or progressive job displacement, will arise at certain times in local areas, and we cannot deny its existence.

Further, we most remember that to the individual worker thrown out of his job, even temporarily, in one of these unemployment pockets, the problem is one of very real proportion and of great seriousness. It should be of at least equal concern to every responsible citizen, whether he represent management or labor, whether he be in government or outside of it. It is incumbent on all of us together to see to it that the human equation is not ignored during these interim periods of unemployment that may be technologically created as a result of automation's growth.

As previous testimony has indicated and as the committee knows, automation covers a very broad field; it embraces a diversity of activities; it is not a simple matter to be adequately described by a single formula. By the same token the effects of automation will be equally complex. It would not, therefore, seem possible to cover all the difficulties which may occur by one over-all formula, panacea, or rigorous code drawn in advance.

Addressing ourselves therefore to the possible development of local instances of unemployment, it seems clear that we must find ways and means of aiding, in a concrete way, those individual workers who maye be affected. Nor is unemployment compensation for the displaced worker, no matter how high the level, the complete answer to his problem. It seems to me that what we should favor, and can favor, is that the main emphasis be placed on the actual finding of jobs for the people who may be displaced.

Specifically, I would advocate that labor and industry join together in a National Labor-Management Council on Job Opportunities to deal with the problems of unemployment created as a result of automation.

The establishment of such a national council, with subsidiary regional and State divisions, would perform important and valuable functions.

(1) It could follow automation's progress in the various parts of our Nation—in entire industries, local areas, and individual companies. Thus it could help pin-point developing localized cases of unemployment.

(2) In such instances, the council would try to encourage industry to expand—through the creation of new products or new markets. It could also encourage new industry to move into these affected areas. Industrial expansion and the influx of new industry would lead to new job opportunities in the afflicted areas.

(3) The council could make suggestions and could also establish procedures for retraining dislocated workers so that they can take over new jobs.

(4) The council should work with Federal and State agencies to accomplish the same ends.

In summary, the council—working at the national, regional, and State levels—would attempt to record automation's development and suggest solutions for any temporary dislocations that its progress may create. In its efforts and by the very nature of its cooperative sponsorship by labor and management, it would have the full help of both industry and labor, and also could have the aid and counsel of national and State governments.

Most important, the establishment of such a council would emphasize that management and labor alike view the advent of increased automation with approval, but that they are mindful nevertheless of its short-term limitations and believe that what a man who may be displaced by automation desires most is another job—and they are ready to help him in his laudable endeavor to find one.

It is fortunate that as we approach the challenge of the promise inherent in automation, we in this country have reached a stage of social maturity where we have at hand both the adequate techniques and the requisite spirit to make possible the harmonious adjustments which may be needed to assure all citizens the continued expansion of our prosperous economy, on high levels of employment, under standards of sound economic principles. I am sure that with the facts known, and freely discussed in such councils as I have suggested, management and labor, together with the public at large, and guided by the facilities afforded by our Government, will apply themselves intelligently and cooperatively so that automation—like the development of atomic energy for peaceful purposes—will indeed prove a great boon to humanity, for the people of this country and for the people of the world, and for the cause of freedom and peace everywhere.

EXHIBIT A. CLEARING MACHINE CORP.

Clearing Machine Corp., a division of United States Industries, Inc., is engaged in the manufacture of a full line of industrial presses—machines which are expressly adaptable for automation and currently in use in automated industrial processes in some of the large mass production enterprises of the country. While it is not precisely engaged in an automatic production activity itself as such—its machines being specially designed rather than produced on a mass production basis—nevertheless its activities have a close connection with automation in that it is serving as the source of the key equipment actually used in automation processes.

Clearing's products cover the entire range of the press field. They include mechanical power presses, hydraulic power presses, smaller open-back inclinable presses, and accessories such as feeding and handling equipment. The jobs they do include drawing, forging, extrusion, piercing, stamping, embossing, blanking, and coining.

Brief description of the press process

Cold drawing of steel sheet is probably the most common of all presswork operations. A precut or preshaped sheet steel blank is placed over a precision die which is stationary and supported by the bed of the press. An upper or mating die, carried by the slide, forces the sheet into the bed. The slide, exerting many hundred tons of force, is driven through a power train from the top, or crown, of the press. At the completion of the pressing cycle, the formed piece is removed from the press.

Dependent upon the shape desired and the material used, the piece may be formed in one or more operations. In a typical operation, a steel sheet blank is fed into the first press and drawn into the initial shape. The shaped piece then moves into a second, third, or more presses where subsequent restriking and trimming operations occur until the desired shape is obtained. Usually in a press line of this nature, there is an inventory of sheets before the first press and a work-in-process inventory between presses. Operators load and unload each press. The number of pieces of one shape produced at any one run depends on assembly production schedules (the piece usually being a component part), the maximum inventory level desired, and the down time required to change the dies to produce another shape.

Recent changes in the press industry

There have been many rapid developments in the press industry during the last 10 years. These developments have resulted in faster cycle speeds and larger, more complex press equipment. They have been spearheaded by the purchaser in his desire for greater production per direct labor hour and lower materials handling costs. Added to this has been the application of presses to parts which were formerly produced by other processes. For the press manufacturer this has resulted in more specially engineered tailormade presses than he sold previously. A capital equipment manufacturer has frequently been described as being in the business of technological obsolescence. This has been particularly true in the press industry recently.

Presses have become larger because the desired shapes have become physically bigger and more complex, thus increasing the overall size of the press. Cycling speeds have also become faster. In explanation, the only productive work accomplished by a press occurs when the material is actually being drawn. During the remainder of the cycle the press is unproductive. Since, due to the nature of the material being worked on, there is a maximum speed at which the metal can successfully be drawn without injury to the material, increased drawing speed is not practical. However, press manufacturers have increased the speed of the unproductive part of the cycle while retaining the slower maximum drawing speeds. This has greatly increased the overall press cycling speed to where 14 to 16 stampings per minute may be made now, against 6 to 8 formerly.

Before this production level arrives, however, material-handling difficulties present themselves. The press becomes too fast for a human operator to load and unload. Thus, the practical speed (and production) at which these new presses are able to operate is limited not by the machine itself, but by the loading and unloading time required. Various material-handling devices have been created to load and unload the presses. In some cases they have not been entirely successful; in other instances, they have. Many of these special material-handling devices have been designed and built by the purchaser's production engineers to meet their own specific needs.

One of the most important reasons for the growing use of presswork has been the increased tendency on part of manufacturers to redesign or initially design their products for pressing. Pressing usually has the advantage over other metalworking processes of little or no scrap, higher production rates, and less direct labor cost.

Present and future developments

It may be interesting and informative to review some of the present considerations in the press industry and their effect upon future developments.

There has been increased cognizance on part of manufacturers of the advantages of presswork as a production process. These, coupled with the increased technological advances in the design of presses and accessories, have permitted the manufacturer to increase output and lower costs. Whether this is automation or not depends on definition. Some aspects, such as materials-handling techniques and various controls, probably are. Others are just normal American ingenuity at work attempting to cut costs and increase output. Perhaps an example will help.

A large appliance manufacturer producing refrigerators decided to reinvestigate the method by which compressor housings were made. The assembly was designed in two individual but different sections. These two parts of the housing were stamped in two press lines, each line consisting of several presses. A thorough investigation of the housing design led to the decision that it could be pressed in two identical parts. Thus, double the number of identical parts would be produced. Because any increase in investment in machinery could now be amortized over twice the number of parts, Clearing designed a new and unique press. Four stages of presswork as in the old press line were required—but this was accomplished within one press structure. The only automation required was in the feeding mechanism (the press was too fast for a human operator), the progressive transfer of material within the machine, and the necessary synchronization. This transfer press now produces 14 parts per minute from 1 machine against 7 parts per minute on the old hand-operated multipress line.

A moment's reflection leads to the old dilemma of the chicken or the egg. Was the influence of automation responsible for the rethinking about design? Or was reinvestigation of design itself responsible for the automation that followed?

Besides increased interest in the design of products to be pressed and a unified viewing of product and press design as a whole, greater weight on the material handling aspects will be evidenced in the future. Emphasis has shifted from cycle speed to the ability to feed material in and products out of the press. Feeding and unloading problems have become the limiting factor in many contemplated designs. Automatic handling of materials between presses and within presses is being given increased consideration.

What will these new trends mean for a purchaser of a press as far as his investment in equipment is concerned? For many manufacturers, the use of automatic handling equipment and presses of larger physical size will mean special rather than standard designs and thus increased investment costs. For others, automatic equipment may reduce total investment as more operations are simplified and compressed into smaller special-purpose machines. Redesign of products for production by presses rather than other manufacturing processes may also reduce investment costs since the investment in press equipment is usually less than that for the equipment used in processes presses replace.

Labor and employment

For us at Clearing Machine Corp., the existing skills possessed by our labor force have been adequate in meeting with the problems we confronted in producing these more advanced machines for use in automated processes. The problems attendant upon automatic production are not applicable in production of the automated machines themselves. As a matter of fact, there seems to be a direct antithesis since automated machines are designed for mass production operations while their manufacture is in each instance a specially designed engineering job often never duplicated. So instead of reducing our staff we have actually added to it particularly in our engineering and designing departments, and, in fact, our whole labor force is larger rather than less.

Thus, the effects of automation as far as our employment is concerned has been to introduce a relative stability in our labor force in an industry which has in peacetime been subject to the normal cyclical characteristics prevalent in capital equipment manufacture. This would demonstrate that in calculating the effects of automation upon labor, it is not only important to look at the labor turnover in the factory using automation where the displacement may occur, but also to look beyond this to see whether or not there are compensatory employment opportunities created directly as a result of the automation development. Clearing Machine Corp. is an example where such constructive consequence has occurred.

EXHIBIT B. ROCKFORD ORDNANCE PLANT

Pursuant to the request of this committee for information concerning our operation of the Rockford Ordnance Plant, as indicated in its invitation to testify at this hearing, and with regard for its endeavor to direct itself toward determining the broad social and economic implications of automation, I would like to submit the following case study.

History of the plant

The Rockford Ordnance Plant is the Government's first all-inclusive attempt or experiment in automation for producing a finite and complicated metal part in large quantities for the national defense. This plant, conceived in 1941 and dedicated from the very beginning to run completely automated, is owned by the United States Army Ordnance, Department of the Army, and is presently operated by United States Industries, Inc., at Rockford, Ill.

The original concept of full automation was developed around the Army's requirements for 37 mm. projectiles. On August 27, 1941, a contract was signed by W. F. & John Barnes Co. to build a pilot facility to produce 4 million such projectiles.

In March 1943 Ordnance requested that the 37 mm. lines be converted to produce 57 mm. shells. In June 1944, due to a change in Ordnance requirements, the Barnes Co. was authorized to proceed on a 155 mm. shell line. On V-J Day, the contract was terminated with the line about 60 percent completed. Until October 1949 the uncompleted 155 mm. line remained in standby. At that time the Barnes Co. was ordered to complete one line of 155 mm. machines.

On March 1, 1951, the Barnes Co. commenced production and made 121,887 shells in the following 2 years. At this point (March 1, 1953), the Ordnance called on United States Industries to assume responsibility for the operation of the facility. Thereupon, the pilot plant, under United States Industries' aegis, made 370,000 shells in the next year. From March 5, 1954, to February 1, 1955, no production contract was let. On February 1, 1955, the plant was ordered back into limited production for 1 year. The plant is in production at this time.

Brief description of manufacturing process

Varying lengths of round-cornered square bar stock are unloaded from gondola cars by magnetic cranes and placed on loading tables which take the stock to cutoff saws where it is cut to billet size. Beginning with the feeding of the original bar stock onto the loading tables, material is not thereafter handled by hand. From the cutoff saws, the billets are moved into the forge shop rotary furnaces and heated. The billets then successively pass through a descaler, a sizing press, a pierce press, to rolling mills, and a cooling, quenching and shot-blasting operations. From here it is sent to the centering and cutoff equipment, thence through a roughing operation, a nosing press, another heat-treating cycle, another cleaning operation, a nose-boring machine, and to the finishing machine. The finishing machinery works the material and when the proper tolerances have been reached, it is discharged to a band-seat groover, a centerless grinder, a nose threader, a band press and then through the paint line. The completed shells are then palletized, ready for shipment.

What is being learned at Rockford

In the experimental operation of the Rockford Ordnance Plant since United States Industries assumed responsibility, the facility has met production goals; we have also constantly been engaged in perfecting the automatic aspects of the operation, fully informing Army Ordnance of all new developments at this pilot plant.

Perhaps the most important fact definitely established has been that automated production of a high-quality precision shell is feasible. In any future conflict, when the availability of the labor supply will be limited, the knowledge that a modern counterpart of Rockford, conceived in the light of present engineering art and past-production experience, could meet maximum production goals with minimum use of vital labor, is indeed comforting.

More specifically, we have determined for the Ordnance that certain operations have functioned notably well. For instance, particularly commendable have been the conveyor system transporting the shells between operations and the manner in which chips generated in the machining operations are conveyed away from the machines. Certain automated-machine operations have performed exceptionally well; e. g., the automatic heat-treatment furnaces, the robot-finish turn machine, the automated induction nose heating furnaces and the rolling-forge mill.

We have also discovered some of the basic difficulties which may be expected in the operation of an automatic shell plant. For example, day-to-day operations are severely handicapped by the inadequate facility for maintenance designed into the special-purpose machinery. Also, from the long-range viewpoint, little allowance was made to replace conventional machinery with improved models as manufacturers made them available.

To aid ordnance in making design decisions for a future Rockford, we have made detailed recommendations to solve those difficulties encountered.

Specifically, to improve the maintenance situation described above, a number of things can be done. In designing equipment which at that time was revolutionary rather than evolutionary, the designers could not be expected to anticipate every contingency. To provide for this, it now develops that more emphasis might have been given to such factors as ease and accessability for maintenance, the use of standard parts and more single purpose rather than multipurpose machinery. United States Industries has also suggested that a definite schedule of preventive maintenance is almost mandatory. With an automated production process, material moves more continuously than in a conventional plant meaning less work-in-process inventory between operations. Thus the temporary inability of the weakest link in the chain to perform effectively is much more serious in an automated process than in a conventional one.

We have also reported to the Ordnance Department that the product and process at the existing Rockford pilot facility are exceedingly rigid. Any alteration to produce other than a 155-millimeter shell would be costly and difficult if not impossible. Any improvement in conventional equipment design or of process of manufacture could not be readily integrated.

It has been necessary, moreover, for United States Industries, in order to meet production goals, to restort to "conventionalization" of certain operations which had been designed to be automated. This has been accomplished although numerous difficulties had to be overcome. Thus it has been ascertained that in designing a plant for automatic-shell production, provision must be made for the contingency that some automatic operations may not be practical, so that prior arrangements should be made for the use of alternative means in order that production not be impeded.

Without minimizing the difficulties which United States industries has experienced in coping with the day-to-day problems at Rockford since it took over the operation of the plant, we feel that the general feasibility of automated shell production has definitely been established. Indeed, the only possible answer in meeting the needs of modern warfare, which requires maximum production with minimum use of labor, lies in the direction of such facilities as the Rockford Ordnance Plant, conceived and built in the light of present technical art and operating experience.

United States Industries has detailed operating records of each item of equipment at Rockford together with concrete technical recommendations for each operation gained during 2½ years of successful production all of which have been placed at the disposal of the Government.

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General observations

As production specialists called in to operate this plant, it appears to us that the planning and engineering that went into its creation was, for that time, a long step forward toward automation in heavy production. It should be remembered, however, that in viewing the Rockford Ordnance Plant from 1955, we are looking at one of the finest automatic factories, now more than 11 years old. It is doubtful that without the type of planning and engineering that went into the plant, automation for heavy manufacture would have been able to achieve its present status. The art of automation has changed rapidly from the time this plant was first conceived. The combination of present art and past operations experience, such as we possess, could today result in an automatic shell plant of outstanding performance.

Thus, after closely examining the results of 11 years of automation at Rockford, and after 2½ years of our own operation of the plant, our considered opinion is that while complete automation, in the sense of an automatic process or series of entirely different machines functioning together, aided only by monitors, has not yet been achieved, automation per se, as applied to single machines or series of machines, has, on the whole, been very successful.

In order to attain complete automation, it seems necessary to proceed by stages—first automating one series of operations, learning from operating experience, and redesigning as necessary. Thus automation is accomplished progressively by degrees as each series of operations is automated. The final step is connecting the automated series of operations together into one automation process. The procedure thus has to be evolutionary rather than revolutionary.

Rockford has proven that the intermediary steps in this evolution cannot be ignored. Many operations there have been successfully automated. Some have not. The end result is that automation of shell production has been greatly enhanced but a completely automatic shall process has not yet been accomplished.

The factors which have prevented a complete automatic functioning of the plant are primarily the mechanical limitations of the machines and the weight and size of the shells, rather than any lack of foresight, ingenuity, or planning. These difficulties can be adequately provided for in any new construction of a plant dedicated to the same concept. The lessons now being learned at Rockford permit a greater comprehension based on experience, which if used to maximum advantage, can afford a fuller realization of the final goal.

The CHAIRMAN. Our first witness will be Dr. Allen V. Astin. Dr. Astin, your agency has undoubtedly been in on the development of many of these automatic computers and other devices in use throughout Government and industry. Besides the Bureau of the Census—which Dr. Burgess told us about last week—I understand that the General Accounting Office, Comptroller's Office in the Defense Department, and various installations such as the Navy Aviation Supply Depot at Philadelphia, and many others have had experience in this field. I hope that you can give us some overall picture of your experience in these different areas as a consequence of your general familiarity with them.

We have, for instance, heard a great deal about such things as the "Tinker Toy" project. Since time does not permit our hearing from all of these projects, however interesting they may be, we are dependent upon you for filling us in on the broad background, Dr. Astin, and we appreciate your coming here.

Dr. ASTIN. Thank you very much, Mr. Chairman.

STATEMENT OF DR. A. V. ASTIN, DIRECTOR, NATIONAL BUREAU OF STANDARDS

Dr. ASTIN. I appreciate this opportunity to tell your subcommittee about the activities of the National Bureau of Standards in this field; also to express some of my own views on the subject of the future of office and factory automation.

I would like first to outline the functions and objectives of the National Bureau of Standards in order to provide a background for our activities in this area. The National Bureau of Standards is a Federal scientific and engineering institution, established to provide unique and essential services to science, industry, and Government. Our most basic function is to provide standards for physical measurement, together with means for their effective use. This responsibility requires unusual competence in the science of physical measurement in all major branches of science and engineering.

Because of the general competence of our organization on problems of physical measurement, it has been customary for other Government agencies to seek advice and assistance from the Bureau on scientific and technical matters. With the rapidly growing importance of technology in our national economy, this service function of the Bureau to other Government agencies has increased. At present approximately two-thirds of the Bureau's total program is devoted to projects requested and paid for by other agencies of the Federal Government.

The Bureau's work on automatic electronic computing machines began as a part of the organization's technical assistance program. In 1946 requests for such assistance came from three different sources: The Bureau of the Census, the Office of the Air Comptroller, and the Office of the Chief of Ordnance. The Bureau of the Census was exploring the possibilities of applying recent advances in electronics to their large data-processing problems. A preliminary survey showed that the prospects were very good. This was followed by a contract placed by NBS with the former Eckert-Mauchley Corp. to prepare detailed performance specifications for a machine suitable for the needs of the Bureau of the Census. The completion of this contract was followed, in turn, by a purchase order placed by NBS for three large electronic data-processing machines; one for the Bureau of the Census, one for the Office of the Air Comptroller, and one for the Army Map Service. This order was filled by the delivery of the first three Univacs.

The problem brought to the Bureau in 1946 by the Office of the Air Comptroller required the services of both electronics and mathematical experts from the Bureau's staff in connection with logistics planning problems of the Air Force. A preliminary analysis of these requirements pointed to the desirability of having available at an earlier date a somewhat more modest computing machine than the expected Univac. This led to the design and development and construction by the Bureau of its Standards electronic automatic computer, commonly known as the SEAC. The SEAC was placed in productive operation almost a full year before the first Univac was delivered, and it has now been operating on an around-the-clock basis for more than 5 years.

Also in 1946, the Office of the Chief of Ordnance asked the Bureau to study critical components and subassemblies for a data-processing machine which the Army was procuring for its Ballistics Research Laboratory at Aberdeen, Md. This led to an active program at the Bureau on the development of materials and components for use in the computing machine field and to the development of reliable evaluation techniques for such components.

A little later the Bureau designed and built for the Department of Defense a mobile and more advanced machine, the DYSEAC. The DYSEAC was turned over to the Department of Defense in the spring of 1954, and is now in operation at the White Sands, N. Mex., Proving Grounds. The availability of the SEAC coupled with the Bureau's considerable experience in this rapidly growing field has resulted in numerous requests for technical advice and assistance in connection with the design and possible utilization of modern, high-speed, electronic computing devices. Before discussing more specifically the nature and importance of some of these requests, I should like to outline some of my own views concerning the importance of these new technological developments to our national economy and to our general welfare. The relationship of these edevelopments to our economy is, I believe, closely associated with the interest of this subcommittee in the field of automation.

Automation is a relatively new word. It has been defined in many ways by various people. It probably means, the process of rendering automatic. From this point of view, the newest thing about automation is the word itself. The development of devices to perform functions automatically is a very old activity. For example, the ancient Romans invented a hydraulic float valve to control automatically the level of water in storage tanks. I would prefer to consider the subject of mechanization which is a broader area of technology, with automation as one of its important subdivisions. The general goal of mechanization is increased productivity; to use machines to aid man in producing more goods and services. Increased mechanization and increased productivity have expanded together. This has been especially noteworthy over the past 150 years, and particularly in the past 50 years.

MECHANIZATION HAS SEVERAL IMPORTANT PHASES

The first and probably the most basic is the replacement of physical energy provided by humans or animals by energy provided by machines powered from mechanical, electrical, or chemical sources. A primitive example is the use of hydraulic energy to operate a flour mill. More recent examples are the use of gasoline to propel automobiles and tractors and electrical energy to turn the wheels of factories. The importance of this phase of mechanization is attested by the tremendous expansion of electrical and petroleum energy sources in recent decades. Even more phenomenal expansion can be expected as atomic-energy sources become available.

A second phase of mechanization is the use of physical measurement. In the older days of hand craftsmanship, items were fabricated by fitting mating parts together or by adjusting an item, such as garment, to the individual size of the user. With the development of the science of measurement, together with instruments for making measurements, it became possible to fabricate items according to a specification. When items are fabricated according to physical characteristics, as defined on a blueprint or specification, they can be used interchangeably. Developments along these lines led to mass production techniques, the essence of which is interchangeability of parts. One of the first persons to demonstrate this technique was Eli Whitney, who showed approximately 150 years ago that rifles could be assembled from interchangeable parts, each one of which was fabricated in accordance with carefully prescribed procedures of measurement. More recent advances in the science of physical measurement have brought about instruments that make certain measurements automatically, as well as instruments which make measurements more precisely.

A third phase in mechanization is the use of mechanical handling techniques whereby materials are carried by machine from one processing station to another. The conveyor belt is probably the best known example of this phase of mechanization.

A fourth phase of mechanization involves the concept of feedback. Feedback merely means the use of the result of a physical measurement at one stage of a mechanical process to alter or control an operation at an earlier stage of the process. A commonly used example of feedback is the thermostat on an automatic furnace. The thermostat measures the temperature at a particular location and feeds the result of this measurement to the controls of the furnace, shutting it off or turning it on according to the temperature observation. Feedback can be accomplished entirely mechanically or with the intervention of human operators in varying degrees.

In the furnace example, a man can be both the temperature-measuring device and the feedback element; he shovels coal or closes the furnace drafts, depending on whether he is cold or hot. In steel production, it is customary to run analyses on the composition of the melts at various steps along the processing line. A human operator may make the measurements with mechanical instruments which can result in an orally conveyed order to modify a phase of the production process as a result of the measurement. In modern petroleum refining, the measuring process, the order giving, and the resulting control modification can all be accomplished mechanically.

A fifth and most recent phase of mechanization is the utilization of advanced and automatic computational techniques. Frequently the completion of the feedback process requires computations of varying degrees of complexity on the results of a physical measurement before a proper control order can be determined. Automatic machines which make possible rapid and reliable computations provide extremely important supplements to the feedback process. It is in this area that the striking recent advances have taken place, providing a basis for extensive future developments. Advances in the tools of computation have another important implication. Hitherto the trend in mechanization has been confined primarily to the processing of physical materials and devices. Automatic computing machines are, on the other hand, concerned with processing numbers. The processing of numbers is an important operation in many activities other than production lines. Business offices such as banks, insurance companies, and retailing organizations, Government agencies, and scientific laboratories, are all concerned with processing numbers on increasingly larger scales. Hence, this phase of the process of mechanization appears to have applications in many areas other than the production processes where so much mechanization has already taken place.

I mentioned earlier that the goal of mechanization is increased productivity, and increased productivity is, I believe, an objective of primary concern to our Nation. Although I am not an economist, it is my understanding that the nature of our economic system is such that it must expand in order to remain vigorous and healthy. In an era when the opportunities for geographic expansion are almost nil, the only practicable means of expanding our economic system is through the development of new products or through the development of techniques for producing products more efficiently. Both of these depend on scientific and technological effort, involving continuing emphasis on mechanization in all of its phases.

A recent analysis by Dr. Raymond Ewell, of the National Science Foundation, shows that the productivity of our labor force, as a result of scientific and technological effort, has increased at a rate over 2 percent a year for the past 43 years. His analysis also shows the productivity rate to be accelerating; it was 3 percent over the past 7 years. The dependence of our increasing productivity on science and technology can be further demonstrated by the fact that approximately half of our labor force is now engaged in producing or marketing materials or devices that were generally unheard of 50 years ago.

Progress in science and in industrial productivity are closely related. Advances in each of the major phases of mechanization, which make possible increased productivity, depend on progress in science and engineering.

Furthermore, the orderly advancement of science also depends upon developments in some of the same areas that are important to the growth of industrial mechanization. The science of measurement is fully as important to general scientific progress as it is to industrial progress. Better instruments and techniques of measurement aid both science and industry. Further advances in the computing-machine field will likewise aid both areas. The interrelatedness of science and productivity is demonstrated by the fact that new and improved production methods make possible new and better tools, material, and instruments for the scientist, enhancing his opportunities for discovery.

I have stressed this interrelatedness because it is important to appreciate that progress in all phases of science and technology contribute to increasing productivity, which is essential to a vigorous economy and a strong nation.

An important characteristic of an expanding economy, dealing with new products and new techniques, is that it must be accompanied by an expanding science. New problems must be solved which are always larger and more complex. It is in coping with such a situation that the new automatic-computing machines assume major significance. Many of the scientific and technological advances which have been made with the use of these machines would have been either impossible or excessively costly to achieve without them. Modern guided missiles and the hydrogen bomb provide two outstanding examples. To date, our experience with these machines shows that they are not used primarily to do old work with fewer people. Instead, we are tackling the important new problem with the same or even more people, thus increasing our capacity to explore the unknown. Viewed in this light, the recent developments with computing machines help to fulfill the current need of science and technology. Advances have now reached a stage where further progress would be impracticable or uneconomical without them.

The utilization of modern high-speed computing machines has, so far, been mainly in the field of science and technology, especially in those areas important to our defense effort. It is extremely likely, however, that their ultimate major use will be in the field of business-office operations. In this area, we now find a situation somewhat analogous to the state of scientific technology before the advent of these machines. Office operating problems have reached a size and complexity that defy further efficient growth unless there is provided better means for handling the masses of information which clog modern offices.

This situation has been very well described by former Assistant Secretary of Commerce James C. Worthy. I should like to quote from one of his talks:

> * * * It is a fact of great significance that the number of clerical workers has increased more rapidly than the number of productive workers during the past half century. Modern productive techniques, with their consequent centralization of direction and control, require increasingly greater proportions of paper-processing personnel * * *. Unless current trends can be halted or reversed, an ever larger and larger portion of the Nation's total manpower will necessarily be absorbed in unproductive recordkeeping overhead at the expense of wealth-creating effort.
>
> The technological response to the current challenge is already clearly indicated. The development and refinement of electronic data-processing systems offers the same possibilities to business that it does to science and to Government. And the end results can be similar: A greater concentration of available human resources on the production of tangible goods and services and a smaller proportionate loss to nonproductive overhead.
>
> As in the case of Government personnel, this development will not lead to large-scale displacement of employees. The process will be gradual and permit ample opportunity for orderly adjustment. Over the long pull, it will result in the gradual diminution of monotonous, repetitive paper-handling work. At the same time, it will gradually increase the opportunities for interesting, creative high-skilled technical assignments. The consequence will be not only greater gains but higher human satisfactions.
>
> The consequences for management are equally significant. One of management's greatest problems is that of securing adequate and timely information on which to base day-to-day decisions. The complexity of modern business organizations has created chains of command that often isolate the decision-making group at the top from the basic facts which are essential for effective, timely control. Paradoxically, it is also true that top management may be literally swamped with undigested facts and with figures too voluminous to use. One of the important gains from the new electronic techniques will be the bringing of the right facts to the right people at the right time * * *.
>
> Every day, new and divergent facts develop which those in responsible positions in Government and industry must carefully consider and analyze. These mountains of data will surely overwhelm us if we continue to follow the practices of those who lived in a simpler time. The electronic computers with their remarkable ability to assimilate and store information for rapid selection and access may be a primary factor for sound, wise public and business policies in the troubled years ahead.

Our Federal Government has the largest business office operations in the world. Hence, it seems logical that if modern data-processing machines have a place in improving the efficiency of large-scale office operations, there should be numerous possible applications within the Federal Government. Our experience has shown that this prospect is indeed very good.

The advisory and consulting services of the National Bureau of Standards have led to a need for keeping abreast of all major developments involving data-processing systems. This experience has enabled me to provide a brief summary of the "state of the art" for its possible interest to the members of this subcommittee. It is included as an appendix to my prepared statement.

CENSUS BUREAU

I mentioned earlier that our first activity with modern computing machines was in assisting the Bureau of the Census. Census Director Robert W. Burgess has already told you of their experience with computing machines so there is no need for me to discuss that phase of our work. There was, however, a related development of the Census Bureau that should be mentioned briefly. This development involved automatic means for translating the data on the record sheets of census enumerators into a form that could be fed directly into their computing machines.

The machine we developed has been named FOSDIC (film optical sensing device for input to computers). The machine reads marks on microfilmed copies of documents that have been marked with an ordinary pencil or pen, and then processes the information into electrical pulses which are recorded on magnetic tape for direct input to an electronic computer such as the census Univac. FOSDIC is designed to reduce the work that is now involved in converting written records into a medium acceptable as input by data-processing machines. This is particularly true since FOSDIC allows considerable freedom in design of the documents and does not require the use of any special writing instrument.

It is anticipated that ultimately the use of this machine will reduce appreciably the massive amount of paperwork entailed in summarizing census information on the entire population. Although designed for census operations, FOSDIC may be generally applied to the processing of other types of information that must be handled in large quantities.

With the development of many large-scale electronic computers in the past few years, there has been an increasing need for equipment to bridge the gap between the machines and their sources of information. This is especially true for computing systems which perform relatively little computation on a large mass of data obtained from many sources. Considerable attention has been given to computers and their input-output equipment but relatively little to "pre-input" apparatus or instrumentation permitting the computer to have direct contact with sources of information. When human beings are considered as sources of information, only two partially automatic means of communication are in general use. These are (1) typewriters of various forms and (2) special marking instruments such as punches or conductive pencils. An alternate method is through the manual preparation of punched cards. To these methods has now been added FOSDIC, a completely automatic machine which processes marks made by an ordinary pencil or pen into a form directly usable by the computer.

PATENT OFFICE

Another unit of the Department of Commerce, the Patent Office, has a particularly challenging problem in the area of possible mechanization of patent search. Our patent system is closely related to the industrial growth and prosperity of the United States. It plays a major role in the creation of new products and processes, yet our patent system is at a crossroads because of the very increasing complexity in the continued program of inventiveness. The present patent examiners are as dedicated and competent as their predecessors, but they face a task that is infinitely more complex than that of even a few decades back. The unprecedented pace of science and technology is producing new facts and inventions at a rate beyond the capacity for patent claim handling procedures which have been developed over the years so that the present staff is unable to keep the size of the backlog of patent applications from steadily increasing. In awareness of this problem, the Senate Appropriations Committee specifically directed the Department of Commerce to make an aggressive investigation of the possibility of mechanizing patent search operations. In accordance with this mandate, a committee, headed by Dr. Vannevár Bush, was appointed. This committee concluded that if the patent system is to continue to make its contribution to our expanding economy, mechanization of the routine aspects of the patent search process is essential, and that the automatic data processing art has reached a stage of development which makes feasible its application to this complex problem.

Accordingly, the Patent Office and the National Bureau of Standarts are cooperating in a joint program of research and development to adapt machine techniques to these Patent Office operations.

ARMY QUARTERMASTER

Our work for the Army Quartermaster Corps gave us experience in coping with the problems of Government purchase and procurement.

In carrying out provisions of the Armed Services Procurement Act of 1947, a number of complications arise in determining the bidder or combination of bidders who will charge the true lowest cost to the Government. True costs require consideration of different freight rates from factories to depots. The bidder himself may state restrictive provisions such as minimum and maximum quantities, or "block" or "hinge" bids whereby he may quote different prices on different quantities.

The attempted resolution of lowest cost for bids on contracts involving a variety of complicating factors, when carried out by manual methods, results in high cost both in time and manpower. On 1 typical operation, 700 man-hours were expended without trying all the possible combinations, and it was estimated that 4,000 man-hours would have been required to calculate all combinations.

A second shortcoming of manual computation is that in some cases it is not possible to solve the problem at all in the time available. For example, a proposed contract for 860,000 woolen jackets to be fabricated for 13 different destinations, estimated to involve 223,000 different combinations, had to be canceled because bids could not be evaluated by manual computations.

Accordingly, a program was established in the Applied Mathematics Division of NBS to explore the use of new mathematical techniques (called linear programing) in conjunction with the use of high-speed electronic computing equipment.

The linear programing computation procedure, as coded for SEAC, is then used with data on the various bids received for each specific

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problem, and the machine operates on the specific problem by first assuming that an award satisfying the various restrictions will be chosen regardless of its cost. A cheaper allocation is then sought, and it is substituted for the first. The search for still cheaper allocations continues until no cheaper award can be found. For the typical problem, about 2 hours of SEAC computation are required before the minimum cost answer is found.

The direct savings achieved through the speed of electronic computation can be illustrated by the fact that, for a problem that would have required 1,000 man-hours of labor at a cost for manual computation of approximately $2,500, the machine could have tried all combinations in about 40 minutes at a cost of $80 or less. Direct savings are also achieved through the saving of time since bidders may limit the effective period of their bids to option periods of 20 days or less from the date of opening bids.

In summary, then, the linear programing technique makes possible the development of solutions to bid evaluation problems in less time, at less cost, and with absolute accuracy.

VETERANS' ADMINISTRATION

The Bureau has also been called upon by the Veterans' Administration for work in relation to actuarial tables. In this case, the Univac system was used to provide the actuarial tables necessary for the new uniformed services survivors' benefit program. Using conventional methods by desk calculation, this would have required an estimated 25,000 man-hours. The job actually took 1,443 man-hours. The cost by conventional means would have been in the neighborhood of $200,000; it was actually completed for about $15,000 with the Univac.

In the course of the entire job, the Univac computed 357,012 numbers to 8 significant figures. The 1,443 man-hours used on the problem included time spent in analysis and process charting, flow charting, coding, preparing desk-calculated samples for checking, preparation for and operation of the machine, report writing, hand editing and checking tables, and maintenance.

The actual time spent by the Univac in generating the numbers (not including checking of programs) was 41.4 hours. The total time used by the computer system was 104 hours. As a comparative figure, a few sample values computed by hand for checking purposes required 55 man-hours.

More significantly, however, the Congress directed that this veterans' insurance program should go into effect within 60 days from the time that the act was signed. The use of the computer made it possible to provide the necessary tables so that the program did go into effect on schedule with maximum benefit to all concerned, something that would have been impossible without the use of these new general-purpose, high-speed tools.

NAVY AVIATION SUPPLY OFFICE

The Bureau has also assisted the Navy in applying automatic techniques to its inventory-control and supply problems. The data-processing application that is now in operation at the Navy's Aviation Supply Office is a good example of better use of present resources. In the Navy supply system, there are some 13 materiel control centers,

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called supply demand control points. These control points have cognizance over certain broad categories of material. In the case of the Aviation Supply Office, the desponsibility is for aircraft, aircraft engines, and supporting spare parts and accessories.

The supply replenishment actions used to be based on quarterly distribution and procurement in accordance with predicted demand determined by existing inventories and demand for a previous quarter. Under this control system, the regular quarterly actions had frequently to be supplemented by special actions prior to the next scheduled distribution in order to take care of fluctuations in actual demands. In some cases, as many as 40 percent or more of the stock transactions were interim transactions reflecting such unanticipated demands.

In an attempt to improve the control system, the program usage replenishment system (PURS) technique was developed in the hope of attaining a more realistic balance between inventory levels and projected requirements based upon program plans. However, the introduction of this system materially added to the computational workload at ASO. To extend the PURS procedure to additional classes of material required an even greater workload. It was therefore reasonable to look toward the adoption of electronic data-processing techniques as a way of accomplishing this mission more expeditiously and more economically.

The electronic computing equipment that has been installed is now at work on this job, so that management may more effectively control the procurement and distribution of supplies to meet requirements.

AIR MATERIEL COMMAND

The Air Materiel Command of the Air Force had a problem of logistics control similar to that of the Navy's ASO. They are now using and actively exploring the further use of computers for logistics management. One of the problems they face is the development of a system which can be expanded during an emergency without requiring a greatly increased staff.

The Bureau has assisted them in this program. In the first instance, the Bureau assisted in the procurement of their automatic device. In the second instance, we are helping to assist the Air Materiel Command in training their supply and logistics personnel at various bases. The interesting aspect about this program is that we have been successful in training GS-4 and GS-5 stock clerks to carry out some of the programing operations for the computer.

I have reports that they are doing quite well. What this means is that for some of the automatic programing, relatively untrained people can be taught to do the work, thereby releasing the more highly trained for more complex work. I might mention here that the Bureau has now had considerable experience in training personnel to operate automatic electronic devices of this sort. I think it is one of the important values of our central computational and data-processing staff.

FEDERAL HOUSING ADMINISTRATION

The experience of the Federal Housing Administration provides an example of how more effective work can be done with the use of data-processing machines. In the low rent housing program administered by the FHA it is necessary to audit income and other statistical data concerning the tenants. With their present staff this can be done only on a sampling basis. Carrying out this operation on the SEAC it was shown that a 100 percent audit would be possible with the same staff. In addition, their staff would be able to give more attention to borderline cases where careful, human judgment is required.

This list is by no means complete. But I hope it has served to demonstrate some of the advantages to be derived from applying modern data-processing techniques to Government operations. There are, in fact, a host of applications which are now in the planning stage or, in an even greater number of cases, still uncontemplated.

In recognition of the demand for Bureau services in this field and of the increasing use of automatic devices for Government operations, the National Bureau of Standards has requested and received initial appropriations from the Congress for the construction of a pilot data-processing machine. This machine is now in the planning stage and will take about 2 more years to get into operation. It will provide Government with a central facility for studying the feasibility of various automatic systems and components for use in machines to serve the particular needs of Government agencies. This pilot facility, which will be highly flexible in character, will be used to study the large variety of problems encountered in numerous Government operations, and will be adaptable for actual sample trial runs of contemplated systems.

The facility will also provide our staff with increased research and engineering experience in order that we may stay at the forefront of new technological advances in this field.

MODULAR CONSTRUCTION OF ELECTRONIC EQUIPMENT (PROJECT TINKERTOY)

There is one other important example of work along quite different lines. This is the one mentioned earlier by the chairman. It deals with our work for the Navy Bureau of Aeronautics on a system for the mechanized production of electronic equipment.

The extensive dependence of modern military equipment upon electronic devices led the Navy to seek ways of increasing its mobilization potential with a system which might eliminate some of the previously experienced difficulties. Important among these difficulties are such factors as (1) extreme dependence on many sources of supply for components which during periods of rapid expansion of production can lead to many bottlenecks; (2) long lead time necessary to get large-scale production lines for military equipment into operation; (3) high degree of variability in product performance characteristics, leading to extensive and complicated maintenance problems particularly for military equipment (various estimates give the maintenance costs of military electronic equipment as 5 to 100 times the initial cost); and (4) extensive dependence of production techniques on hand methods. It is a curious anomaly that this industry, whose products have been widely heralded as making possible automatic factories for other industries, is in its own production technique extensively dependent on manual labor. Basic design systems for the production of electronic equipment have changed very little since the mid-1920's, when the inverted cake pan type of chassis assembly was evolved.

The project consists of two parts: First, the development of a modular system for the design of electronic equipment and, second, the design of automatic machines for processing and assembling the components of the modular system. Solution of the first was considered essential to the successful completion of the second since early analysis led to the conclusion that any mechanized system which would assemble conventional components in conventional layouts would be unacceptably cumbersome and inflexible. The modular design system is based on a standard building block, a ⅞-inch square, notched ceramic wafer. Components such as resistors, capacitors, repetitive circuit elements and tube sockets are made integral with the ceramic building block. These are assembled in skyscraper-type structures yielding a standard module for each circuit stage. Devising circuit layouts by this approach involves planning in three dimensions rather than the conventional two-dimensional approach heretofore employed.

These standard building blocks and modules are readily adaptable to automatic machine methods. During the assembly, 100 percent automatic testing is provided for components and subassemblies. The resulting project shows an extremely high degree of uniformity. Flexibility is assured in that a production line can be converted in a matter of hours from building a civilian-type product, such as a radio receiving set, to building complex military electronic equipment. This provides an unusual capability in standby capacity.

This is, of course, the major reason sponsored by the Navy Bureau of Aeronautics, increasing standby convenience being most important in mobilization planning.

Further proof of the flexibility is provided by the fact that a wide variety of types of electronic equipment have been designed for assembly by the modular technique. The modular design and assembly also afford an unusual possibility in standard packages for subassemblies with attendant simplification of the maintenance and repair problems.

These developments were turned over to industry about 2 years ago and several companies are now engaged in the production of electronic items using modular techniques.

SUMMARY

This has been a long presentation on my part, I know. But I think it was necessary to give the members of this committee a fairly complete history of the development and application of techniques in automation. If I may summarize now, I would make these points:

Automation is not new. It is the natural outgrowth of scientific research and development in the field of mechanization. It is new only in the sense that recent advances in the field of electronics and communication can now be applied to mechanization. And just as previous advances in mechanization have helped to further our civilization and to increase our productive capacity, so automation offers promises of even greater benefit.

Automation makes use of the high-speed capabilities of electronic data-processing devices and computers. These new devices promise to serve society in several ways. They will be effective tools for increasing productivity and for production control. They will relieve considerably the massive paper-handling and processing problems of the Nation's businesses and offices. They will be high-speed servants for the efficient management of complex organizations, such as Government agencies. They offer to science and engineering a magnificent tool for undertaking scientific problems which were hitherto impossible because of the length of time required for solution.

These, I think, are the promises of these new machines. But I urge you to remember that this enlargement of our productive capacity comes about because of advances in mechanization which, in turn, are dependent upon an enlarged scientific program. As we grow, we become more and more complex. Continued research helps us to cope with this complexity.

Thank you very much.

The CHAIRMAN. Thank you, Doctor.

Now I assume it will be all right to place in the record this appendix A of your statement?

Dr. ASTIN. Yes, sir.

(The information appears at the end of Dr. Astin's testimony.)

The CHAIRMAN. You have obviously given a lot of time and thought to this statement. We appreciate it very much.

You stated that these developments were turned over to industry about 2 years ago and certain companies are now engaged in the production of electronic items, using modular techniques. On what basis did you turn these developments over to industry, Doctor?

Dr. ASTIN. Whatever inventions were involved in this process were assigned to the Government and free licenses were granted to any responsible organization which wished to use them.

The CHAIRMAN. In other words, they are in the public domain?

Dr. ASTIN. That is correct.

The CHAIRMAN. Anybody can use them?

Dr. ASTIN. That is correct.

The CHAIRMAN. And they pay nothing for the use of them?

Dr. ASTIN. Yes, sir.

The CHAIRMAN. And one does not have any benefit or privilege over the other?

Dr. ASTIN. That is correct.

The CHAIRMAN. They are all on an equal basis?

Dr. ASTIN. Yes, sir.

The CHAIRMAN. No special privileges?

Dr. ASTIN. That is what we try to do.

The CHAIRMAN. That is fine.

Mr. Moore, do you have any questions?

Mr. MOORE. I have heard it said, Dr. Astin, that we have the DC-7 in production a year earlier because of these computing machines. As a layman, I can't precisely visualize what the computing machines did to save us a whole year. Can you enlighten me on that?

Dr. ASTIN. I am not familiar with that specific problem but I might be able to answer it in general terms. The design of the strength of the materials which make up airplanes is a very complicated and intricate problem, and the conventional methods of carrying out computations on the strength of the materials had reached the stage where complex devices, like large airplanes, where it was almost impossible to carry them through, and it would be my expectation that the computing machines were used for that problem in solving structural stresses, design analysis problems. Such a claim does not appear at all unreasonable to me.

Mr. MOORE. How much of the impetus for the present wave of research and progress in the sciences would you attribute to war and defense expenditures, that is, to the necessities of winning a frightful and regrettable war?

Dr. ASTIN. I think that the great majority of it is probably due to that. It is my feeling that this is one of the so-called beneficent returns of the war. That is, there were substantial developments made of necessity to solve immediate war problems. Certainly, the recent advances in high-speed computing machines were stimulated by war needs. That is, the first of the so-called modern machines, the ENIAC was developed and financed by the Government in order to permit the ordnance people to solve ballistic problems, preparing bombing tables, range tables for guns, and things of that sort. Modern ordnance required these machines and stimulated putting money into them and developed the art so that these machines are now available for countless civilian applications.

I could cite scores of similar examples, where wartime developments have been turned to peaceful uses. As a matter of fact, this project, Tinkertoy, had its inception in production techniques which we worked on during the war to bring about the mass production of proximity fuses, and it was the extension of this work which led to Tinkertoy project, again, for a civilian application, but this modular construction of electronic equipment has great potential benefits in the civilian economy; that is, ultimately it will make possible production of better radio and television receiving sets for less money.

This is the ultimate end of such activity.

Mr. MOORE. Do you have in mind any other new products that we accept as commonplace now that are really due to or dependent upon the development of automation as the word is generally bandied about.

Dr. ASTIN. The very large computing machines that I have talked about have only limited application in industry so far, although smaller type computing machines have been used extensively in machining operations. For example, in carrying out operations on a punch press or a large lathe, or milling machine, it is necessary to position the piece of apparatus in different places along the line and to control the amount of cutting or drilling or boring, and these controls are all handled by computational methods, rather simple computers compared to the large ones we have been speaking about for office operation.

Now, there are all sorts of examples. One of the most familiar examples of modern technology is the electric light bulb. It is my understanding that there are now machines which will build these simple devices with about—well, one example I recall is a plant producing over a billion light bulbs a year, with about 230 people.

Using 1927 techniques, it would have taken about, I think something over 75,000 people to carry out the same production. It was a very large factor.

Most of the modern plastics that we have are the result of automatic production processes, as well, of course, as scientific research and development. The chemical industries, petroleum industry, are very highly mechanized, and it is quite unlikely that these materials could be made available in the quantity they are at the price they are sold for if these production techniques were not available.

One might take another familiar example: Frozen orange juice. This is a product which is relatively new, everyone is familiar with it, but, again, this is a result of advances in recognized production techniques. It makes reasonably fresh orange juice available to everyone throughout the country all the year around.

The CHAIRMAN. Mr. Ensley, would you like to ask some questions?

Mr. ENSLEY. Thank you, Mr. Chairman.

You just mentioned a moment ago the phenomenal developments in the manufacture and distribution of the common light bulb.

Dr. ASTIN. Yes, sir.

Mr. ENSLEY. Have these developments that you just referred to actually been put into practice?

Dr. ASTIN. The one on the light bulb that I mentioned, as I understand, is actually in operation.

Mr. ENSLEY. The reason I come back to it, yesterday Mr. Cordiner, of General Electric, indicated that there had been technological developments in the production of light bulbs.

Dr. ASTIN. That is correct.

Mr. ENSLEY. But in spite of these developments, material and labor costs have increased faster, and the light bulb is one of the few electric devices where the price has actually increased in recent years, as compared with television, radio, and other appliances, where the prices have gone down.

Now, if your figures are correct with respect to the tremendous technological developments, I am wondering why the price of light bulbs is not coming down.

Dr. ASTIN. Maybe they would have gone up more. I don't know the answer.

Mr. ENSLEY. With respect to these rapid technological developments, do you see in them any implication for the structure of the American business, between large and small business?

Dr. ASTIN. Well, I mentioned in my formal statement that one of the important phases of this mechanization involved the measuring process and interchangeability of parts. One can expand this general concept and come to the business of standard components, which are specified dimensionally, according to their physical characteristics. One of the trends, or characteristics, I should say, of our modern economic system is the use of job part suppliers. This is a feature which we did not have extensively several years ago. This is possible because one can specify a part, according to its physical characteristics, and procure it from a job supplier. I think that there is very apt to be an increase in this, and this, of course, is one of the things which allows diversity of our production facilities. One of the trends of this whole process makes possible the purchase and utilization of standard subassemblies which are supplied by other manufacturers.

Mr. ENSLEY. So small business can benefit as well as large business?

Dr. ASTIN. They can benefit if the trend goes in one way. There are some organizations that like to do everything themselves, but the increased use of standard components specified according to carefully designed physical characteristics makes possible this extensive use of job suppliers.

Mr. ENSLEY. I have some questions in the area of education on which I would like to get your judgment. Over the last hundred years the United States has benefited a great deal from the people that have immigrated to this country—basic scientists and mathematicians. Perhaps that stream might be reduced in the years ahead. Do you see coming forth in this country the type of basic research needed for technological development? Are we developing, in other words, new Einsteins in the United States?

Dr. ASTIN. Well, we don't develop Einsteins. I think they are born, but you can provide facilities for them to help them along, and President Eisenhower stated about a year and a half ago that he believes strongly in extending the support which we give to basic science. Certainly this is the goal of the National Science Foundation. The role of the National Bureau of Standards is to serve science and industry, and it is my feeling that this has been—I mean the responsibility for supporting basic science—has been accepted as a requirement of national policy.

Mr. ENSLEY. It is true, we hear quite a lot of talk about this. Do you feel that we are actually performing in this area? Are our programs consistent with these worthy statements?

Dr. ASTIN. I think we could do more, but——

Mr. ENSLEY. You think we could do more?

Dr. ASTIN. I am a strong believer in the importance of scientific research and development. I think my general statement implied that.

Mr. ENSLEY. This, of course, involves, does it not, starting down in the lower grades?

Dr. ASTIN. Our most critical problem in this whole area is getting more young people to take up science and engineering for a career, and make it possible for them, after they select science and engineering for their careers, to obtain good educations.

Mr. ENSLEY. You have to start really in the grade schools, don't you?

Dr. ASTIN. I think the critical area is the high school. I think most people, more people, select their careers at the high-school level than almost any other period of life.

Mr. ENSLEY. Thank you very much.

The CHAIRMAN. Are you disturbed, Doctor, by reason of the information that has been brought to our attention recently that in this country only 27,000 engineers will be graduated next year, whereas Russia will graduate 50,000; and only 50,000 technicians will be graduated in this country next year, whereas in Russia they will graduate 1,600,000?

Dr. ASTIN. Yes, sir; I am gravely concerned over this situation, and I think every citizen in the United States should be.

The CHAIRMAN. We are losing out there; aren't we?

Dr. ASTIN. Yes, sir.

The CHAIRMAN. And it could be very serious in the course of 5 or 10 years.

Dr. ASTIN. Yes, sir; it could.

The CHAIRMAN. Do you have any recommendations to make as to how we could overcome that major deficiency?

Dr. ASTIN. Well, this is sort of out of my area but, as I said, it is a subject I am very much concerned about, so I have given it some thought.

The CHAIRMAN. Can you think out loud?

Dr. ASTIN. I think that the critical area is the high-school level and it is primarily high-school teachers. I don't think we pay our high-school teachers enough, and I don't think that we can get teachers who will inspire people to take up science and engineering as a career unless these people themselves are sold on it, and, with the great shortage we now have of scientists and engineers, it is difficult to get anyone with any competence to do the teaching in the high schools at the present time.

I had an interesting report that might also interest you. As you know, we had a number of scientists attend the Geneva Conference and talked with the Russian scientists who were there, and one of the Russian scientists talking to our people said that he had read that we were concerned about our shortage of scientists and engineers and volunteered information as to what they were doing about it. They apparently are gaining on us in that area.

He says they pay their science teachers more than anybody else. They give special bonuses of extra good homes or summer homes, and things of this sort, to their science teachers. In other words, they have a situation where a man who is teaching science will get more than a man who is doing research or engineering.

The CHAIRMAN. You think in this country, our critical point is the high school?

Dr. ASTIN. Yes, sir.

The CHAIRMAN. And we should pay our high-school teachers more and we should do for them something that compares favorably with what Russia is doing with the scientists?

Dr. ASTIN. We should seek to get better qualified high-school teachers and we can only do this by paying them more.

The CHAIRMAN. Yes, sir. Well, Doctor, after I read your statement again, it is possible I will want to ask you some more questions. I hope I may have the privilege of doing so and getting your replies attached to the correction of your testimony when you get it.

Dr. ASTIN. I will be very glad to help in any way that you ask me, sir.

The CHAIRMAN. Thank you very kindly, sir. We appreciate your cooperation very much.

(The appendix previously referred to follows:)

APPENDIX A. THE STATE OF THE ART OF AUTOMATIC DATA-PROCESSING MACHINES

The art of automatic data processing, based on the use of the high-speed, electronic, digital computers, is only about 10 years old. This new technological advance came about through the application of developments in the field of electrical communications and in the design of counting devices used for nuclear physics research to massive mathematical computations. The need for bombing and firing tables for World War II gave a special impetus to this application and led to the first all-electronic digital computer, ENIAC, which is still in service at Aberdeen Proving Ground.

Today, the automatic data-processing system is a complex assembly of machines and communication and control devices that are able to receive, store, and process information. The information that is processed may be data for statistical tables, payroll computations, inventory reports, accounting data, information on insurance payments, and other kinds of information, such as data for scientific and engineering calculations. In effect, the automatic data-processing system is a production line for many different kinds of information, and thus is a general-purpose tool.

It is a tool, not an electronic "brain," because it does exactly what it is told to do by the people who plan exactly what is to be done and who give the machine system detailed instructions for every processing step.

The automatic data-processing system has certain major characteristics that give it greater versatility than any other tools used in paperwork processing and in extensive mathematical calculations. It is automatic and self-sequencing. It can carry out long and varied sequences of operations in accordance with the plan laid down by the people who prepare the job to be done, without the need for human intervention until the specified job is done.

This equipment operates at high speed. The first modern digital computers, mark I at Harvard and several developed at the Bell Laboratories, were built up of electromechanical relays such as those that are used in telephone switching centers. Since 1946, when ENIAC was formally dedicated, electronic devices such as vacuum tubes and diodes have been used so that the equipment operates internally at electronic speeds. In today's automatic data-processing equipment, 2 numbers 10 digits long can be added together in a few ten-thousands of a second. With components and designs that are already proven, it should be possible to build machines capable of adding or subtracting ten-digit numbers at a rate of 100,000 times in a single second. This high-speed characteristic can be directly translated into enormous savings of time and cost.

The automatic data processing system has a machine "language" which consists of patterns of electrical signals that can be used as code symbols for numbers and letters of the alphabet, just as in telegraphy the Morse code is used to transmit messages from place to place. Because the data processor is able to communicate by means of electrical signals, it is able to translate information from the hole-no hole code patterns on punched cards or teletype tape, from impulses originating in modified typewriter keyboards, and from records made on magnetic tape or wire. It is able to receive and transmit information automatically over any desired distance.

The automatic data-processing equipment is able to make certain very elementary yes-or-no decisions, and to follow different courses of action in accordance with these decisions. For example, in processing records of checks that have been issued and cashed, the machine can be directed to compare the serial number of each check as it is processed against the serial numbers for checks against which a stop payment has been placed. Whenever such a check is located, the machine system will take different action than in the routine cases; for example, it might print out a special notice requiring investigation. The system can use this limited decision-making abilty to keep track of the number of operatons of a certain type it has carried out, and, when a prespecified number have been completed, to either stop or to turn to a different sequence of operations.

The automatic data-processing system provides for large-capacity data storage and for high-speed selection and retrieval of information so stored. All these characteristics give the system unusual adaptability to a wide variety of conditions affecting the way data originates, how it is handled, communication of data from place to place, and processing to provide a variety of records and reports necessary to effective management.

The data-processing system which provides such versatility has four principal parts: input-output devices that enable information to be exchanged with the outside world; and arithmetic-logical unit where computations and other operations are performed on the information sent in to the system; an internal storage or "memory" where information (which includes the data to be worked on, the instructions provided by the human operators are translated into specified sequences of operations that are to be performed.

Input-output devices include equipment to read and punch paper tape or punched cards or to produce a printed page as well as magnetic tapes. The magnetic tape is usually a ribbon of metal or plastic with a thin oxide layer that can be magnetized for the encoding of information. Most computer tapes, as used today, are about one-half inch wide and store about 200 characters to the linear inch so that a single reel about 7 inches in diameter can store information equivalent to that which could be recorded on about 20,000 punched cards. The

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tapes can be written onto or read back through reading-writing heads which convert data recorded as magnetized spots into the electrical signals of the machine language. Reading or writing to and from these tapes proceeds at a rate of about 1,500 10-character words each second. These words can be read automatically from any distance over which it is practical to transmit electrical signals through wires, cable, radio, or other communication links. It is therefore possible to store information recorded in this way in low-cost space or in remote underground vaults for safekeeping.

Internal storage or memory usually provides space for about 1,000 to 4,000 10-character units of information, including both the instructions to the machine system and the data to be worked on, at one time. The devices used for this internal storage include cathode ray tubes like the tubes used for television screens, arrays of tiny magnetic cores that are the size and shape of the letter O, and magnetic drums which are metal cylinders whose surface is magnetically recorded with the information to be stored.

The arithmetic and control units are built up of circuitry that accomplishes the desired switching and counting functions necessary to select and read information to and from the input-output units and to carry out the operations of addition, subtraction, multiplication, division, comparison, and the like. Today, these circuits are built up of tubes and diodes, but transistors are being used experimentally, and machines using magnetic rather than electronic components are being designed.

Commercially available automatic data-processing systems for business management applications include the Remington Rand UNIVAC and the IBM 702 systems and a variety of automatic data-processing systems using magnetic drum storage for internal memory, such as the ALWAC (Logistics Research), Circle (Hogan Laboratories), CRC or NCR systems (National Cash Register), Elecom (Underwood), Datatron (Electro Data Corp.), 650 (IBM), Miniac (Marchant), and Monrobot (Monroe).

Commercially available automatic data-processing systems such as the IBM 701, the 1103, or UNIVAC scientific computer, RAYDAC, designed by Raytheon for Navy, and the NORC, especially designed by IBM for naval ordnance research, are used principally for scientific and engineering computations. Other large-scale systems, such as IBM 705, UNIVACII, BIZMAC, and RAYCOM and small-scale magnetic drum systems such as Bendix, Librascope, J. P. Rea, and UNIVAC file-computer are in various stages of development and should be available soon.

Nearly all these automatic data-processing systems may be ordered on either a rental, lease with option to purchase, or outright purchase basis. Quotations for delivery are usually on the order of 6 to 9 months. Prices for purchase of the large-scale automatic data-processing systems are typically about $1 million or more. Prices for purchase of the typical drum systems range from about $50,000 to about $300,000.

The moderate-priced machines differ from the large-scale systems primarily in speed of operations, e. g., 500 operations per second as versus 5,000 or more, and in slower or less versatile input-output provisions, e. g., 500 characters per second as versus 10,000 to 15,000. Magnetic tape units have been announced for some of these automatic data-processing systems and will soon be available at extra cost.

Current development efforts on automatic data-processing systems for business management applications stress the development of improved capacity and speed of input-output devices and of greater capacity and faster access time to large-volume reference storage. The new system concepts include the provision of multiple access to large-capacity data-storage devices, i. e., by the computer, by independent processing devices less complex than the computer, and by people operating interrogation keyboards (typing in the number of a desired record which is then searched for by the system and printed out). The manufacturers of both large-scale and of moderate-priced automatic data-processing systems equipment are working on such developments.

In addition, various data-storage devices, such as magnetic drums, can be used independently of a large-scale computer for filing and looking up information, and may well be indicative of progress toward the automatic files of the future.

The CHAIRMAN. Mr. Hollengreen is our next witness.

Mr. Hollengreen, while you are president of the Landis Tool Co., of Waynesboro, Pa., and its affiliates, I understand you are also president of the National Machine Tool Builders' Association, representing some hundreds of companies engaged in the manufarturing of basic metalworking tools, and in putting them together into control and automatic assembly lines.

You may proceed in your own way.

Mr. HOLLENGREEN. Thank you very much, Mr. Chairman.

STATEMENT OF M. A. HOLLENGREEN, PRESIDENT, NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

Mr. HOLLENGREEN. Gentlemen, as the chairman said, I am M. A. Hollengreen, and I am president of the Landis Tool Co., of Waynesboro, Pa. I am also president of the Gardner Machine Co., of Beloit, Wis. Both of these companies manufacture machine tools, specifically grinding machines.

During the last year I have also been president of the National Machine Tool Builders' Association. This is a trade association which represents companies that manufacture more than 90 percent of the country's machine tools. These companies have developed the kind of automation that is used in automobile plants and in the metalworking industries generally. Of course, they are not concerned with the automation that is built into business machines, the automation of oil refineries and chemical plants, and similar kinds of automation that are not directly associated with machine tools.

With the committee's permission, I am going to divide my statement into two parts:

First, I shall explain what automation means to the machine-tool industry. I shall be speaking from the point of view of an industry which developed automation as distinct from one that uses it.

Second, I am going to tell you why, in my judgment, the country must have much more rather than less automation. The alternative to more automation is a decrease in the standard of living.

Before coming to these points, I should like to say the machine-tool industry is in complete agreement with the witnesses for the industries that use automation. My statement will serve principally to emphasize their statements from the point of view of the industry that developed automation.

THE NATURE OF AUTOMATION

I shall begin with some facts tabout the machine tools, in general, and automation, in particular. Without these facts the concept of automation is easily blurred.

We say, in the machine-tool industry, that machine tools are the master tools of industry. They cut and form metal in a manner absolutely impossible by hand processes. For this reason everything made of metal is necessarily made on machine tools or on equipment made on machine tools. This is true of automobiles, tractors, and refrigerators for the civilian. It is also true of aircraft, tanks, and guns for the soldier.

Over the years, there has been a steady development in the art of building machine tools. This development has taken two directions. First, the accuracy and power of machine tools have been greatly increased. Second, their speed and productivity have been correspondingly increased. In consequence, we can now make things like jet engines that could not possibly have been made in 1905 or 1925. We can also build many more automobiles a year than we could in 1925.

I mention these parallel developments in machine-tool building because they serve to put automation in its proper perspective. Automation is merely a general term which covers the most recent developments of the past half century with regard to the speed and productivity of machine tools. These developments account for only some of the many developments in accuracy and power as well as in speed and productivity that have taken taken place since 1900.

Actually, machine-tool engineers do not talk about automation. They have been building automatic devices into machine tools for 50 years. They naturally take pride in their most recent accomplishments, but they expected them. They do not regard automation as something entirely new and unforeseen.

I think I can make this point clearer by telling you about metal-cutting lathes. Back in the days after the Civil War when lathes were first developed, the operator had to put the workpiece in and take it out by hand in order to make a single outside cut. Then a turret lathe was developed on which two or more cuts, both internal and external, could be made without removing the workpiece from the machine.

Next, the industry developed lathes with more than one spindle. It devised means for moving the workpiece automatically from position to position in the machine, and from spindle to spindle. This was what is called the automatic chucking machine. By the 1920's it was possible to perform 10 or 15 operations on such a machine without moving the work by hand.

Little by little, electric and automatic controls were added to chucking machines so that by World War II there were hundreds of these machines turning out thousands of identical parts a day. Then the word "automation" was coined, sometime just before Korea.

Since we first heard of automation there have been further improvements in chucking machines. They consist mainly in devices for automatic gaging which enable the machine to correct its own errors. But, largely, they represent continuations of previous developments.

Chucking machines involve a great deal of automation, but it is not what has been referred to as Detroit-type automation. To the machine-tool builder this means merely a transfer machine. In such a machine a raw piece is loaded at one station and held in place for the first operation. It then moves automatically to a second station where a second operation is performed. This process can be repeated through many stations. Transfer machines have been built as long as football fields.

Let me give you a specific example of automation in the Detroit sense. It comes out of my own plant.

I have here a rough piece of metal. This is cast steel. The problem is to manufacture it into a valve for an automobile engine.

I believe you have it there.

The CHAIRMAN. We have one.

Mr. HOLLENGREEN. This rough piece is cast steel, and the problem is to manufacture it into a valve for an automobile engine. There are

16 valves in an 8-cylinder engine. The number of valves needed for any single automobile model, therefore, runs well into the millions.

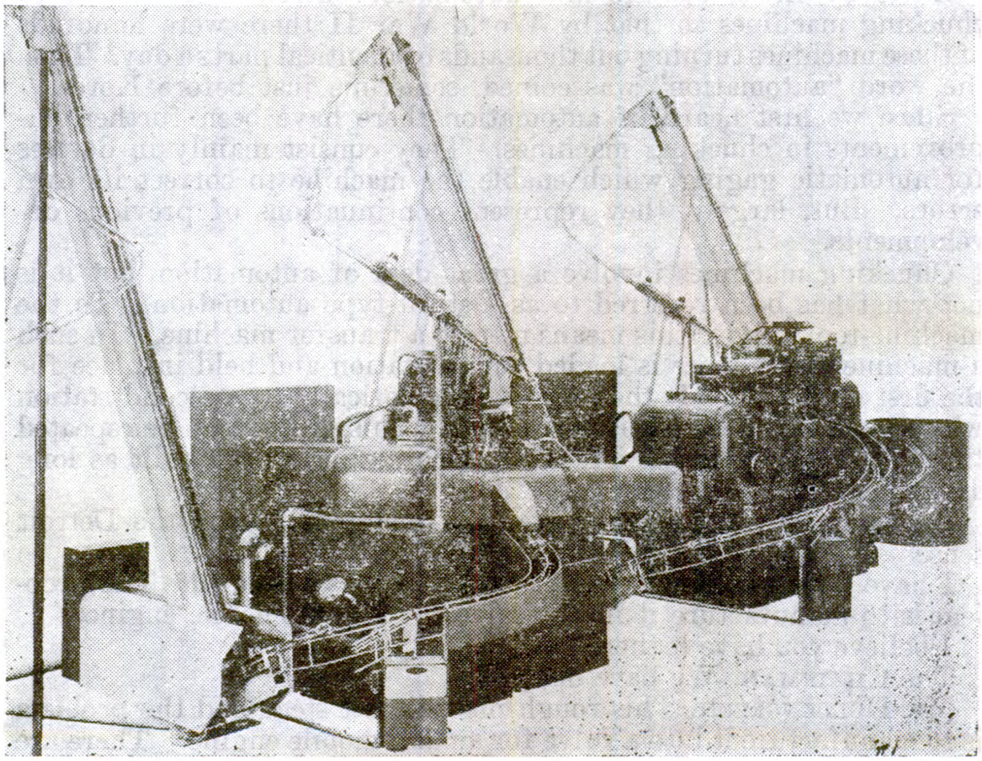
Here I have a finished valve. It has to be very precisely ground because it has to move up and down through a steel bushing with just the right clearance. It cannot fit too closely. Yet it must fit so closely that gases cannot escape between the stem and the bushing. The problem is how to turn millions of rough pieces like this into precisely ground valves at a cost which will permit a low price for the car.

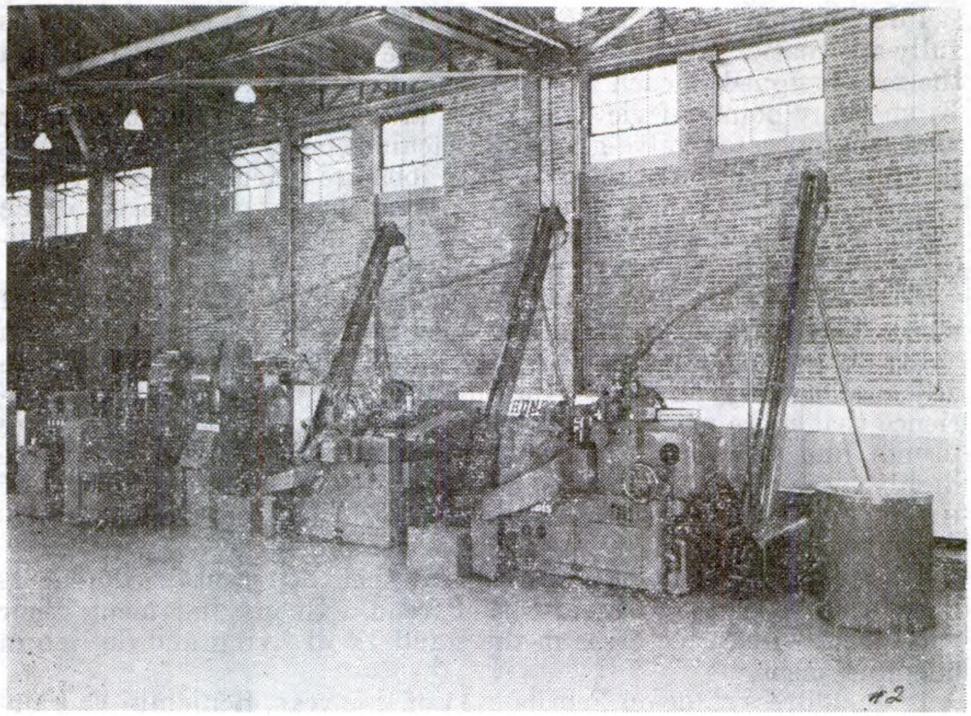
I have here, and I have supplied the committee with, photographs of the automation line we built to produce these valves.

Photograph No. 1 shows the first two pieces in the line. The rough pieces are automatically fed into the line at the first station, which is on the right-hand side of No. 1 photograph. Then they move up a chute and are loaded into the first machine. After being ground on the first machine they pass to the second machine for a second operation, and so on through the cycle.

Photograph No. 2 shows the whole line, which in this case consists of only three machines to complete the entire valve. I might add that photograph No. 3 shows an automated line of precision-grinding machines for grinding the inner races of ball bearings completely.

Before these installations were developed, the pieces had to be loaded and moved from operation to operation by hand. This took time, several minutes per piece, and over long production runs these minutes add up to hours and days and months. Before this kind of installation was available, a maximum of 275 valves could be ground in an hour. We can now manufacture 450 in an hour. In addition, human errors have been eliminated. We achieve much greater accuracy. Scrap has been reduced to a minimum.





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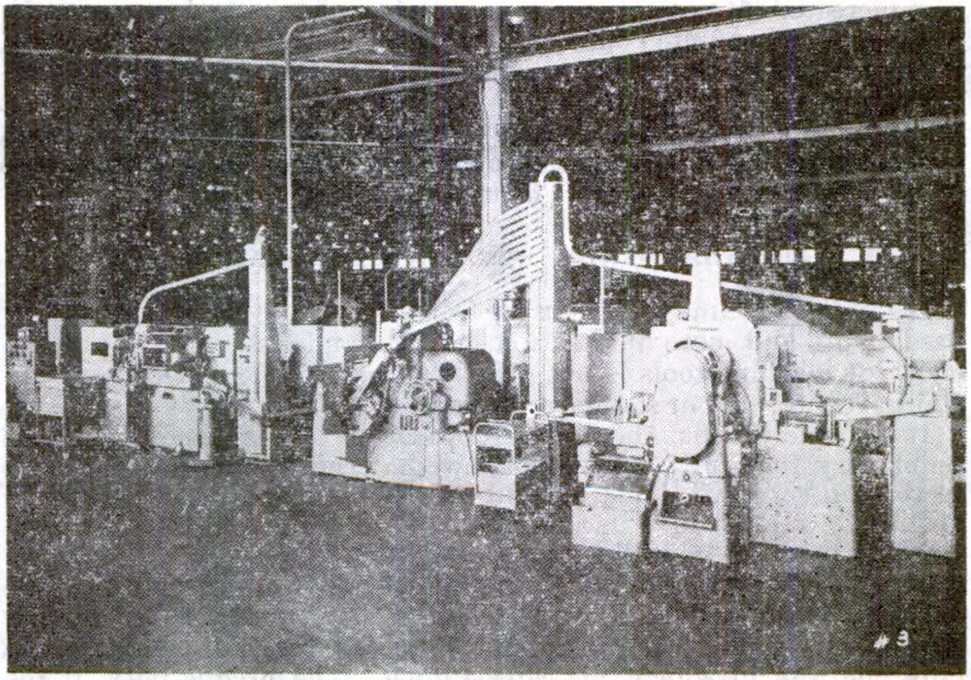

#3

I do not want to give the committee the impression that this line is fully automatic. The machines have to be attended at all times. And the men assigned to such a line have to be well trained and efficient. From many points of view their jobs are better than the jobs of the men who operated valve-grinding machines before we designed this installation. For one thing, the new jobs are safer because the men can keep their arms and hands away from the hazardous area of the machines. In addition, the new, interesting jobs call for more technical knowledge and less sheer manual labor than the old.

To a machine-tool builder, this valve installation and all the rest of automation are merely the latest steps in a process which has been going on for many, many years. For a century we have been gradually mechanizing our metalworking plants. We know from experience that more mechanization means lower costs, more sales, more profits, and very much more employment. The nations that have highly mechanized plants are the ones with the highest standard of living. In this country, the companies with the most modern equipment have prospered and increased their employment.

There is no reason whatever to believe that the recent developments called automation will reverse this trend. In my judgment, their only effect will be increases in the standard of living and decline in unemployment.

In an address made on February 11 of this year, Benjamin F. Fairless, chairman of the board of the United States Steel Corp., gave some interesting statistics. He pointed out that while during the period from 1939 through 1953 the population of the United States had increased 22 percent, the total number of jobs had increased by 35 percent. He pointed out further that in the field of manufacturing, itself, where automation has advanced most rapidly, employment during this period has gone up 73 percent, or more than three times as fast as the population. "The record clearly shows," Mr. Fairless said, "that this rapid increase in employment has occurred chiefly because of mechanization, not in spite of it."

II. THE COUNTRY NEEDS MORE AUTOMATION

We in the machine-tool industry feel very strongly that our country needs more and more automation, not less and less. If the productivity of machine tools is not greatly increased there will be a substantial decline in our standard of living by 1975.

It seems to me that the present population trends demonstrate this point very forcefully. We all know that the overall population is increasing very fast. The present estimate is that it will increase 55 million by 1975. But it is also estimated that the labor force will increase only about 15 million.

The question then is how 15 million people are going to produce enough for 55 million people. There is only one possible answer. The country's output per man-hour must be increased. And there is only one way in which this can be done. The productivity of the country's machine tools must be increased. This means more and more of what we have been calling automation.

The need for more automation can also be demonstrated by looking back a few years. Suppose we tried to manufacture a modern Ford or Chevrolet with the machine tools of 1908. There is some doubt whether those old machines had the power and accuracy to produce a modern car, but let us assume they did. The point is that they were much less productive than modern machines. If they could manufacture a modern car at all, it would take many times the man-hours that are now required. And the cost of a car would be greatly increased. It has been estimated it would cost some $65,000 to manufacture a modern car with the machines of 1908.

Looking ahead once more, we need not go so far as to predict that an automobile will cost $65,000 in 1975 if it has to be manufactured with the machines of 1955. With a larger population, and a relatively smaller work force than in 1955, such an automobile would certainly cost somewhat more than it does today. The continuing demand for larger and more powerful cars, the steady increase in wage scales, and the trend toward a shorter workweek will make it inevitable that the $2,500 car of today will cost at least $10,000 in 1975 if it has to be manufactured with the machines of today.

I should like to leave you with these questions: How many automobiles a year can be sold for $10,000 apiece? How many men would be employed by the automobile industry under these circumstances? And I should like to draw the obvious conclusion that unless we continue to make our machines more productive, to provide them with more automation, if you will, we shall be faced with a situation in which the ordinary man cannot buy automobiles and other products we now regard as necessities. We shall be face to face with a substantial lowering of the standard of living.

But I am confident we shall not go in that direction in America. All through the years the same doubts and fears have been expressed about improved mechanization. When Cartwright developed the power loom, Elias Howe the sewing machine, Mergenthaler the Linotype, men wondered whether there would be jobs. History, and the history of our own times particularly, answers these doubts and should dispel these fears. The whole pattern has been one of lower costs and prices creating greater demands resulting in more employment in much better jobs. The evidence all indicates that the pattern will continue.

The CHAIRMAN. Your statement has discussed a lot of important phases of this subject, and will be helpful to us, Mr. Hollengreen.

I assume that you do not predict a shorter workweek for 1965?

Mr. HOLLENGREEN. I mentioned 1975. I will be surprised if it isn't shorter, and for one I shall be in favor of it. I think that modern management has to assume an enlightened attitude in that direction, and I think that the trend is definitely toward a shorter workweek, and that automation will help bring it about.

The CHAIRMAN. The reason I said 1965 is because we have used that 10 years when asking the question heretofore. Do you expect the shorter workweek to come by 1965 or come some time between 1965 and 1975?

Mr. HOLLENGREEN. I am an engineer, basically, and designer and manufacturer. I would hesitate to hazard a guess on that, Mr. Chairman.

The CHAIRMAN. In listening to your statement I noticed one interesting point you brought out, namely that these machines help to remove the danger, the hazards that the worker has heretofore had to assume. It removes also a lot of the drudgery. If the machine reduces both danger and drudgery, it is certainly a fine thing for our country.

Mr. HOLLENGREEN. I believe that is particularly true. I started out as a machinist, myself, and I had the unfortunate experience of losing a finger on my left hand in my work. You see, with an automatic machine, you don't have your hands in there putting the work in, taking it out, and coming close to the cutting surfaces. You mentioned another thing, Mr. Chairman. It would be a good thing for our country. It is my firm personal belief that should we get into a hot war, automation is going to be one of the blessings that we will experience. It will help us produce more and more shells, and repetitive parts, that we will need during a time of war.

The CHAIRMAN. We certainly cannot compete with the totalitarian countries in manpower. We know that.

Mr. HOLLENGREEN. That is right.

The CHAIRMAN. And so about the only way we could make up for our lack of manpower is to have automation and machines to turn out a lot of industrial production.

Mr. HOLLENGREEN. I think that is going to be very true in case of a war, although I would like to say that the large majority of all the metalworking done in this country today is still done on single-purpose, hand-operated machines.

The CHAIRMAN. As far as the war is concerned, I don't see how any country can afford to start a war when each side has the bomb that can destroy not only the other side, but the entire world. The atomic bomb was powerful, the hydrogen bomb was more powerful, but I assume the cobalt bomb is really it. That could destroy the whole universe.

Mr. HOLLENGREEN. I hope I never see it.

The CHAIRMAN. That is right. We had two wars, world wars, and in each war each side had some destructive means that were never used, for the obvious reason that each side knew that the other side would use these destructive weapons on it.

I think we can only hope that if we were to have another war that the same situation would prevail, that neither side would dare use these devastatingly destructive weapons on each other.

The question of Russia being ahead of us in engineers and technicians, I think is an interesting question. It has been raised several times in these hearings. You have heard the statements made here, that while we will graduate 27,000 engineers next year, 1956, Russia will graduate 50,000, and while we will graduate 50,000 technicians, Russia will graduate 1,600,000. Would you like to comment on that?

Mr. HOLLENGREEN. Yes, Mr. Chairman. Thank you very much.

I had a note here. I was going to ask permission to comment on Dr. Astin's statement.

I heartily agree with everything he said, and from my layman's and manufacturing point of view—and I happen to be a mechanical engineer, myself—I think the fact that we are falling way short in the development of engineers is almost as serious as anything else that this Nation is confronted with today. I think that the number of engineers we have in the future may well determine our future. I think it is quite serious, and I agree that we don't pay our teachers nearly enough. We should do everything we can to make the profession of teaching a better one, and one that highly informed, trained, and responsible people will strive to be in.

There was one other thing off the subject but with your permission I would like to comment on.

The CHAIRMAN. We would be glad to have your comments about anything you feel important.

Mr. HOLLENGREEN. Thank you.

The question of the cost of electric light bulbs came up this afternoon. I know nothing of the manufacture of electric light bulbs, but the machines that make electric light bulbs are made on machine tools, and perhaps one of the reasons that the price of electric light bulbs has not come down is the fact that the life of them has been extended phenomenally over what they were 10 or 15 years ago and they are very different light bulbs and perhaps more intricate to manufacture. Their longer life, perhaps, would bring the net price down quite a bit. They are much more efficient today than they were then.

The CHAIRMAN. Would you like to comment on anything else that has been brought up here in the hearings, or anything that you would like to bring up?

Mr. HOLLENGREEN. There was one witness who talked about the effect of taxes on automation, and the future of our standard of living, and so forth, and I would like to bring home the point that when you consider that Russia had practically no machine-tool industry some years ago, she may be making more progress relatively than we are, as far as the machine-tool building aspect is concerned. You know, the countries that won the war, and the last two big wars, were the countries in the last analysis that had the best machine-tool industries because machine tools are the only machines that can make other machine tools. They are the only ones that can regenerate themselves. A locomotive cannot make another locomotive, and neither can an electric motor make another electric motor. Machine tools are made on machine tools, and they are the master tools of all industry, because when a war breaks out the first cry you hear is that there is a bottleneck in machine tools.

I would very strongly recommend, from my viewpoint, that some way be found to make it easier for our industrial plants all throughout this country to put in more and better and more modern machine tools so that this Government will have them in time of emergency. They will be in place, they will have men trained on them, and we can go right to work, rather than wait until a war breaks out, and then cry that we don't have enough machine tools. I believe that something—I know it probably may not be popular in some areas—but a realistic depreciation and obsolescence write-off will make possible efficient, modern metalworking plants in this country with which to defend our Nation from attack. We won't have much time to start the next time.

The CHAIRMAN. That is right. We had plenty of time to get ready in the last two wars.

Mr. HOLLENGREEN. That is right. The British helped hold us up a little.

The CHAIRMAN. We won't have that assurance in the future?

Mr. HOLLENGREEN. That is right.

The CHAIRMAN. You have brought up a question that has not been brought to our attention before. It escaped my attention. I didn't know the Russians were ahead of us in machine tools.

Mr. HOLLENGREEN. Perhaps I did not make myself clear about the Russians. My point was that they may be making relatively more progress today than we are because they have in effect started from scratch. As Dr. Cledo Brunetti, director of engineering and development of General Mills, Inc., stated when he appeared before you on October 25, 1955, Russia has made astonishing strides in the past decade or two. He cited Nation's Business magazine for September 1953 which reported that in 1938 the Soviet machine-tool industry was producing 1,800 machine tools a year of 100 different types; in 1940, 65,000 of 500 different types; a probable 260,000 of perhaps 3,000 types in 1955. This rate of improvement is astonishing. The Russians know the need of machine tools for waging war and machine tools are one of the first things besides raw materials on which they are concentrating today.

The CHAIRMAN. You think they realize that between Russia and Germany that that was their weakness?

Mr. HOLLENGREEN. There is no doubt about it. You know Hitler had more machine tools and newer machine tools in place in his factories than we did in the United States. That is one of the reasons why a little country like Germany, in my opinion, held out so long and produced the aircraft, ships, and Panzer divisions it did.

The CHAIRMAN. The tax writeoff is helpful in the direction you discussed?

Mr. HOLLENGREEN. Mr. Chairman, I certainly think it is. May I go back to what we were just talking about, Hitler and Germany. He realized that in order to wage a mechanical war, and all wars are that from here on out, I believe, he would have to have the best machine-tool industry possible. For the years before the war he realized Germany had to get the obsolescence out of its plants and he went to the metalworking industry and said that any productive metalworking capital equipment you buy will be an expense item for tax purposes. That is how he built up his great machine-tool industry. That is why, not going to that extreme, I would advocate that capital, metalworking equipment, be allowed to be charged off at a much more rapid rate so that we can get rid of tremendous obsolescence in our own plants. Congress made a great stride last year in permitting more realistic depreciation methods, but I don't think it is far enough. If it can be made so that the manufacturing plants, metalworking plants, in this country would want to replace their machines it would be helpful to our whole economy and enable us to compete in world markets. Over half the machines in this country are over 10 years old. They don't wear out these days, they go obsolete. If realistic depreciation methods are permitted, not to help the manufacturers alone but to help our country help itself, we would have a much better industrial plant in being in case of the next war. We have all this obsolescence today, in my opinion, because of unrealistic depreciation policies in both business and Government.

The CHAIRMAN. I am very much impressed with your proposal, myself.

Mr. Moore, would you like to ask any questions?

Mr. Moore. One sometimes hears that we ought to stockpile machine tools. What rate of obsolescence would there be in this stockpiling?

Mr. Hollengreen. That depends on two things, Doctor, in my opinion: One, on the speed with which new machines are developed, first, and, second, it will depend on what type of product those machines will have to produce in time of war. The stockpiling of machines is the best thing this country has done, so far, to protect itself but that as of just a few days ago has apparently been stopped in its tracks by the Defense Department. That is why it seems to me that if industry could see its way clear through realistic depreciation to buy its own machine tools, the country could fall back on these in an emergency and industry would keep its own tools modern and efficient at no net cost to the Government. That, in my opinion, is the obvious urgent thing we need to do.

Mr. Moore. I don't know precisely how to phrase this question, but what portion of one of these modern automated machines, for example, is adaptable to other uses, and how much of it is sort of a superstructure related to the transfer operation between otherwise standard machines.

In other words, if you wanted to change the size of this valve which you have shown us, how much cost would be involved in shifting this machine over to a new size, and so forth?

Mr. Hollengreen. In that setup I would imagine it would cost anywhere from 24 to 40 or 50 percent. You see, this automated handling is all special, depending on the particular type, size, and shape of the piece you are going to produce, so that you draw it up for an individual part, but the basic machine can be used on anything that is cylindrical in its type and within the range of the machine.

The Chairman. Will you please insert in connection with your remarks any further information you have about Russia being ahead of us in the making of machine tools, and, if you can, distinguish between those used strictly for military and those for industrial products?

Mr. Hollengreen. Mr. Chairman, that is practically impossible, because most any machine tool, with a change in tooling and other changes, can be used either for civilian or for war uses. In fact, the machines that were used during Korea, in my opinion can practically all be converted—those that were bought for military use can be changed back to civilian use, and used for about 10 percent of their original cost.

The Chairman. Any further information about Russia on machine tools that you may have, or be able to obtain and insert with your remarks, will be appreciated, sir.

Mr. Hollengreen. Surely.

Mr. Ensley. I wonder, Mr. Chairman, if Mr. Hollengreen would comment on the outlook of the machine-tool industry as he sees it for next year? It is a little off the subject, but it is such an indicator industry.

Mr. Hollengreen. Anybody who makes a prediction is going out on the limb, but I think business next year in the machine-tool industry should equal very closely what it has been this year, but that does not mean that the industry will be operating at capacity because it is not at capacity now. I think if some realistic depreciation methods on productive capital equipment were evolved it would stimulate the industry, and whether I happen to be in the industry or not I think it is absolutely mandatory that we have a healthy machine-tool industry in this country.

Mr. ENSLEY. About what level would you say it is operating now? What rate of capacity, or can you measure it in percentage?

Mr. HOLLENGREEN. I would say that it is operating between 50 and 60 percent, but that is an estimate.

Mr. ENSLEY. You believe on the basis of orders and indications now that you probably will have as good a year next year as this year?

Mr. HOLLENGREEN. That is right, but not in all areas of the industry. One of the things, I might add, and in my own company particularly, that is limiting our output today is engineers.

Mr. ENSLEY. Is that right?

Mr. HOLLENGREEN. Yes, sir; because of this automation and all of this mechanical handling, it takes from three to four to five hundred percent more engineering per machine shipped out the door than it did before, and our engineering department is limiting our output through the shop as of today.

Mr. ENSLEY. Thank you.

Mr. MOORE. I say this partly facetiously, but if you had more engineers automation would move faster and more people would be out of work?

Mr. HOLLENGREEN. I am glad you brought that up. That is a cycle that few people understand, and I don't think they understand it in Europe at all, with all due respect. If you come out with a new product that is manufactured in multiples, large numbers, producers buy more machinery. The more machinery they buy, and the more automated machinery they buy, the cheaper the price of that article. The cheaper the price of that article, the more people can buy it, but the more people buy it—to come back to the first instance—the more people are needed to make it. I believe that that is that simple three-point cycle that Europe yet doesn't understand, and it is that cycle that made this country what it is today, I believe.

Mr. MOORE. Well, of course, I agree with you.

The CHAIRMAN. Thank you very much.

Mr. HOLLENGREEN. Thank you.

The CHAIRMAN. Before we adjourn I would like to submit for the record a letter addressed to me by the vice president, Mr. K. W. Heberton, of the Western Union Telegram Co., dated October 27. It is in answer to statements that were made before the committee concerning the Western Union being a monopoly.

In conection with the letter certain documents were attached, but I don't think it is necessary to insert those documents, because excerpts from them are contained in the letter. The letter will, however, be inserted in the record at this point.

(The letter from Hr. Heberton is as follows:)

THE WESTERN UNION TELEGRAPH CO.,
Washington 4, D. C., October 27, 1955.

Hon. WRIGHT PATMAN,
Chairman, Subcommittee on Economic Stabilization,
Joint Committee on the Economic Report,
Senate Office Building, Washington 25, D. C.

DEAR MR. CHAIRMAN: May I direct your attention to the testimony before your committee on Tuesday, October 25, contained in volume 6 of the official transcript of the hearings on automation and technological development. I am particularly concerned with the reference characterizing Western Union as a monopoly, and should like to take this opportunity, for the record, to clear up this serious misapprehension.

Far from being a monopoly, Western Union competes with one of the world's largest corporations, the American Telephone & Telegraph Co., whose assets exceed $13 billion—50 times greater than Western Union's; with the Government-subsidized and tax-free airmail service; and with 12 international telegraph carriers.

A. T. & T.'s competition with Western Union extends not only to the Bell System's oral services, but also to the telephone company's selective private telegraph line (leased wire) and teletypewriter exchange (TWX) services. With regard to the competition offered by A. T. & T.'s selective telegraph services, it should be emphasized that the Bell System's participation in the total national telegraph revenues has increased during the postwar period from 18.5 percent in 1946 to 32.6 percent in 1954 and is steadily increasing.

A subcommittee of the United States Senate Committee on Interstate and Foreign Commerce declared on June 22, 1953, in Senate Document 53, a copy of which is attached:

"The domestic telegraph business must fight 3 powerful competitive services, 1 of which it has no hope of ever meeting on equal economic terms through no fault of its own. That service is the domestic airmail, which is subsidized by the taxpayers of which Western Union is one, and which has made heavy inroads on long-haul message service. The second competitor is the telephone system, the most direct and effective competition the telegraph industry has. While the Federal Communications Commission in recent years, with one very minor exception, has ordered several reductions in long-distance telephone rates, the cost of local telephone service has increased materially, and applications are pending in many States for further increases.

"The third competitive operation which the telegraph company must meet is the private-line telegraph service and the teletypewriter exchange service, two record telegraph services available to and employed by volume telegraph users. These competitive services are maintained and operated by the telephone company * * *."

I should like to invite your particular attention to the statement in Senate Document 53 that:

"Significantly, when the Domestic Merger Act (Public Law 4, 78th Cong.) was enacted, it was assumed that the merged Western Union Co. would acquire the private-line telegraph service and the teletypewriter exchange service and thus handle all domestic record communications. This has not been realized. The decline of 33 percent in Western Union's volume from 1945 to 1952, contrasted with the increase of more than 50 percent in the telephone company's teletypewriter exchange service revenues, is extremely significant."

To further complicate Western Union's problem of competing with a virtual monopoly in the voice field, which is in ever-increasing measure draining off the cream of the volume telegraph business, A. T. & T. filed with the Federal Communications Commission on September 23, 1955, a complicated tariff schedule which would offer special rates to volume users, for a combination of voice and telegraph communications.

As will be noted from the enclosed copy of Western Union's protest to the Federal Communications Commission, Western Union has pointed out to the Commission that the proposed A. T. & T. tariff is designed to give that company an unfair competitive advantage in the leased wire telegraph field, by offering a combination of voice and record communications which it alone can do, thereby completely eliminating Western Union from the leased-wire telegraph field. The FCC, incidentally, has suspended this A. T. & T. tariff and has ordered a hearing to be held on November 21.

With respect to the international telegraph field, where Western Union is under a congressional mandate to divest itself of its international telegraph operations, it will be of interest to you to know that on September 8, 1955, the FCC authorized A. T. & T. to construct a cable system between the United States and Hawaii, with the express provision that the cable system could be used by A. T. & T. for telegraph, as well as the telephone services. Western Union has pointed out to the Commission the inconsistency of permitting A. T. & T. to enter the international telegraph field, while Western Union is under a mandate to quit that same field, and has urged the Commission to reconsider and modify its order approving the operation of this cable system, so as to permit the record communications carriers to meet all record communications requirements. A copy of Western Union's reply brief setting forth these considerations in greater detail is also enclosed.

While it is generally recognized that duplicating telephone service is not in the public interest, and Congress, in enacting the Merger Act of 1943, approved a similar policy in the record message field, that policy has never been effectuated because the telephone company has refused to quit the telegraph field. To the contrary, A. T. & T. is constantly expanding its operations in the telegraph field, as evidenced by the two most recent FCC proceedings cited in this letter.

I am appreciative of this opportunity to correct the record, and to make it clear that, far from being a monopoly, Western Union has to contend with the most intensive and powerful competition faced by any public service company.

Very truly yours,

K. W. Herberton.

The Chairman. The committee will stand in recess until tomorrow morning at 10 o'clock.

(Whereupon, at 3:38 p. m., the committee recessed until Friday, October 28, 1955, at 10 a. m.)

AUTOMATION AND TECHNOLOGICAL CHANGE

FRIDAY, OCTOBER 28, 1955

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC STABILIZATION OF THE
JOINT COMMITTEE ON THE ECONOMIC REPORT,
Washington, D. C.

The subcommittee met at 10 a. m., the Honorable Wright Patman, chairman, presiding.

Present: Representative Wright Patman, chairman of the committee; and Senator Joseph C. O'Mahoney.

Also present: Staff Economist William H. Moore and Staff Director Grover W. Ensley.

The CHAIRMAN. The subcommittee will please come to order.

We have with us this morning Dr. Bush and Dr. Nourse.

Two weeks ago we started this series of hearings with an introductory general session—an introductory chapter designed to give us the general setting of the problem by hearing from Mr. Diebold and Professor Buckingham. In fact, this will be the 15th session of this committee on automation. It is equal to 3 weeks, 5 days a week. It has been one of the most interesting hearings that I will ever attend. I have never attended a hearing where I knew less about the subject matter, however. I have been anxious to learn and I have learned some things.

In the intervening days we have heard from well over a score of witnesses closely associated with production and industry in varied fields. We have heard from Government officials, we have heard from the representatives of six great labor unions, from representatives of the machine-tool industry and the manufacturing industry generally, along with the experts from individual companies. We appreciate all that these people have done for us and the things which they have given us to think about.

Today it seems appropriate to conclude these hearings with a final or summary chapter by hearing from two distinguished citizens who are in a position to be somewhat aloof from the day-to-day problems of manufacturing, personnel, and selling, and are yet expert in appraising developments. These two participants have been chosen for their respective backgrounds in the field of technology and economics.

Dr. Vannevar Bush has been president of the Carnegie Institution of Washington since 1939. From this vantage point and his position as Director of the Office of Scientific Research and Development during World War II, and as the first Director of the Research and Development Board of the Department of Defense, he has been in a position to watch the progress of scientific development for more than two decades. He is known also as the originator and builder of a differential-analyzer machine. This, I take it, would be one of the grandfathers of the computers and numerical-control devices that we have heard about during the past 2 weeks.

Dr. Edwin G. Nourse was long associated with the Brookings Institution and was its vice president from 1942 until 1946, when he became the first Chairman of the Council of Economic Advisers, established under the Employment Act of 1946 somewhat as an executive department counterpart to the Joint Committee on the Economic Report. He is the author of numerous works on economics and public policy and in this field of production and the economic system especially, one on Industrial Price Policies and Economic Progress; and another, Price Making in a Democracy.

Dr. Bush and Dr. Nourse have been receiving transcripts of the testimony presented each day. Within the limits of their valuable time they have been studying and contemplating the evidence which has been presented to the subcommittee in the past 2 weeks. I am sure that they will be of great help to us in getting this problem into proper perspective. With the benefit of their respective and combined experience, we should be able to understand the place of technology in the free enterprise system and especially to evaluate present trends and where they are likely to take us in the years ahead.

We are delighted to have you gentlemen with us. I believe on the calendar we have Dr. Bush listed first.

Dr. Bush, we will be delighted to hear from you first, please.

STATEMENT OF DR. VANNEVAR BUSH, PRESIDENT, CARNEGIE INSTITUTION OF WASHINGTON

Dr. Bush. Mr. Chairman, I would like at the outset to congratulate this subcommittee on the excellent treatment which has been devoted to this difficult subject as a result of these hearings. I have read the statements and followed the arguments with great interest. In fact, I haven't done much else for the past 2 weeks, Mr. Chairman. I cannot say that I agree with all that has been presented, but, of course, if there were full agreement on all points there would hardly be sound reason for discussion. But I have certainly learned a great deal about the subject.

Automation may be defined as relegation to a machine of the function of performing operations previously performed manually. Any operations which are repetitive in nature, and which may be specified by a formula or a schedule, may be thus turned over to be performed by a group of interconnected devices—mechanical, electrical, pneumatic, and the like. It is an entirely different question whether it will pay, or whether it is socially desirable, for work thus to be transferred.

Even mental work may be thus relegated to a machine, if it comes within a similar definition, as has been well illustrated by Dr. Burgess. It is being done to great advantage today. This is not usually called automation, but it is of equal importance to the automation which substitutes for manual work. In fact, in the long run it may be of even greater importance to our progress, for it enables us to know more and to know it more accurately.

But automation may be thought of in a much broader sense. Man now has the dream of making machines which are like himself, and which can hence become his slaves. And he has progressed a long distance toward this objective, and will progress further. Yet there are inherent limits, and severe conditions to be met, as the evolution of machines proceeds under man's direction.

The functions of the human mechanism for which he would find substitutes are primarily physical and mental; he would replace manual operations and the mental processes that go with them. He is not much concerned with one property of living organisms, the ability to take in food and convert it into energy. In fact, he assigns this function to a separate category of machines, his engines; for food he uses coal and oil, and thus he produces power to drive his automobile or electricity to run his factory. He will no doubt use atomic and solar energy for the same purpose. In fact, he is doing so well at this that he has more convenient and powerful means than nature has produced. And when he builds a machine to replace a man he has little worry about its metabolism, for he can readily supply the energy needs.

For doing mechanical things he has a host of devices: Motors, relays, hydraulic cylinders, pneumatic devices. With these he can accomplish movements at far greater speed than can a man's arms or legs; he can exert far more powerful forces; and he can perform the movements far more precisely and reliably. His machines never tire of their work. Thus even although he has never produced the marvelous physical structure and chemistry of the human muscle, he has many, and in some ways, better substitutes.

When the operation to be performed is strictly repetitive, and no real thinking is involved, the substitution of a machine for a man is straightforward. One merely has to reproduce the mechanical movements involved. But it is possible to go beyond this. Feedback may be introduced, and the machine thus caused to exercise a sort of judgment. Mr. Reuther has given a good example of this in the form of a lathe which notes the variations of its product and readjusts its tools accordingly. And for this purpose we have many remarkable instruments; photocells which can sense the exact position of elements, radioactive devices which can instantly sense the thickness of a sheet of metal, gages to which the thickness of a hair is a gross error, and a host of others. Thus he can make his machines self-regulating and self-correcting.

The performance of the machine need not be fixed once for all, it can be to a certain extent flexible, and the instructions given to it may be altered, and may be very complex. Thus a milling machine may be controlled by a magnetic tape and caused to perform any sequence of operations that such a machine is capable of, time after time, without error and with precision. And by merely altering the tape a wholly new sequence of operations may be introduced. We hardly approach the versatility of the human mechanism in this way, for the same man can ride a bicycle, drive a car, swim a river, or add a column of figures. We could make versatile machines, no doubt, that would do many things. But here, in particular, one meets the difference between what it is possible to do, and what it pays to do.

Machines may be made to cooperate so that the performance of one is correlated with the work of the others. In particular it is possible to arrange a line of machines to perform a sequence of operations, passing work on from one to the next. We here encounter what is usually called systems engineering in one of its phases.

It is in the mental area that the most fascinating progress is now occurring. When a man sits down to solve a mathematical problem a very large part of what he does, not all, is repetitive and carried out in accordance with fixed formulas. When he manipulates a mass of statistics, fills out forms, draws curves of relationships, prepares statements of inventory, earnings, and the like, a large fraction of his work is simply the routine application of fixed rules. All of this can be done for him by machine, much faster and more accurately than he can do it himself. It is being done, largely by digital machines, with great memories, high precision, and enormous speed. The results of such calculations can sometimes be used directly to control his machines. But more often they simply present partial results for his judgment. A machine can even calculate the progress of an election, and present interesting trends. But it cannot predict the result, unless told what rules to use in so doing, and, as we know from experience, the human instructions in that regard may be faulty. The human brain is a marvelous mechanism. Machines can excel it in precision of memory and operations, and in speed. But they by no means match its extraordinary complexity and flexibility. And, in my opinion, they never will, at least within our lifetimes.

There is another aspect of such organic mechanisms as man's body, namely, self-repair, which is of importance in our grasp of the trends on mechanization. If the blood supply to our brain or heart is cut off, we not only stop functioning, we die and disintegrate. If the power fails on a machine it stops, but it can soon start again. On the other hand, if I am slightly wounded nature goes to work automatically to repair the damage. Machines can be given a certain amount of this function of self-repair. When a complex machine is built, performing a hundred operations on the cylinder block of an engine, it will not do at all if the whole machine shuts down every time a tool breaks or becomes dull. There should be automatic means present so that when this occurs a new tool is promptly substituted and the work goes on.

Incidentally, this should be done automatically.

But a man goes on for years with only occasional ministration by a physician or surgeon, while a complex machine always has men about to minister to its minor ills, and also occasionally to tell it what to do.

A primary characteristic of living organisms is the ability to reproduce. Indeed, life began, according to some scientists, when there appeared, in a primeval soup, organic molecules which had the capacity to build exact replicas or models of themselves by assembling constituents from their surroundings. When the men now present on earth have died, others will have been reproduced to take their places. It is true that machines are used to make more machines; in fact, this is one of the central features of our present industrial civilization. But machines do not reproduce themselves automatically. Nor is it likely, in spite of the fancy of science writers, that we will soon see a machine that is useful its own right, and which also builds

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other machines just like itself. Our automatic machines have to be built by men using judgment and ingenuity; they have to be controlled by men, and maintained by men.

Here lies the primary limitation on the whole trend of automation. It is quite possible to dream up fantastic machines that could do all sorts of things. But it is an entirely different matter to design and build a machine that will pay for itself. If more highly skilled labor is used in building a machine and maintaining it, including the labor that goes into producing its materials, than the machine could replace over its probable useful life, then it makes little sense to build it. There are not many men who have the skill and judgment to build and maintain complex machinery and use it wisely.

Thus the limitation on automation is not a matter of techniques or instruments. It is a matter of costs, and of the supply of highly skilled individuals.

I can illustrate by a personal example. For many years I have built my own pipes, not that I save anything by so doing, quite the contrary, but because I like to make pipes. A few years ago I made an automatic machine that would take a block of wood and automatically turn out a pipe bowl. I hasten to say that I was not the first one to make such a device, for they are commonly used; I just did it in a different way. I spent many hours building this gadget and enjoyed it.

I have made pipes by its use. But I figure out that I would have to live for several hundred years in order to come out even on the hours of labor per pipe, and I doubt if either I or the machine will last that long. But I didn't do the job for profit. And, in introducing automatic machinery into our affairs we need to do so at a profit. This is not merely that industries must carefully balance the costs before they proceed with a particular installation; we can depend upon it that they will. More broadly we need to be sure that the progress of automation provides a profit, or more accurately a benefit, to society as a whole. It is for this reason that I welcome the fine review of the whole subject which is being produced here under the auspices of this committee.

I have personally no great fears in this regard. We have already gone a long way down the path, and we have prospered as we have done so. As far as the country as a whole is concerned I see only benefits in the long run, and some problems which accompany them without doubt, if the process proceeds gradually as it has in the past, and as I believe it is bound to. It is a different story when it comes to the individual. There may be an overall public benefit in a particular move, and at the same time distress and hardship for individuals. It is here that wisdom and restraint are imperative.

Senator O'MAHONEY. Doctor, if I may interrupt, I have been reading that part of your paper which was presented before I came in and I feel that this may be an appropriate place to ask you to turn back and give us a more amplified definition of "memory" as you use it in connection with a machine. I see a great difference between the human memory and the memory of a machine; that is, I think I see it, but I would like to have your explanation of that.

Dr. BUSH. There is a great difference, sir. This is a memory: A piece of paper with some words placed on it, and we use that simple form of memory all the time, to supplement our own cerebration. Machines do it in similar but more complicated ways.

Senator O'MAHONEY. When I think of memory, Doctor, I think of my wife, because she can remember in the utmost detail things that have happened all along the years.

Dr. BUSH. That is one of the most remarkable features of the human brain, that you and I can bring back into our consciousness things that happened 50 years ago—I think you and I go back at least to that time, don't we, Senator?

Senator O'MAHONEY. Oh, you are right.

Dr. BUSH. And bring them back with accuracy when those things have been registered in our brain simply by connections between some certain cells, by neurons, and the like. One of the most remarkable things about the human memory is that the brain cannot only remember, but produce recollections back after many years. The machine does the same thing, but uses a different mechanism. Instead of using cells and neurons, it uses dots on a photographic film or magnetic impressions on a magnetic tape, and it can store these and at any time it can search them and bring them back.

Senator O'MAHONEY. You say "can search and bring back"?

Dr. BUSH. Can search and bring back, and that is a very important part of the operation, for the machine can have millions of words, or millions of figures stored on a magnetic tape, and yet in thousandths of a second it can find the one that is needed for a particular calculation and bring it back.

Dr. NOURSE. Can the machine forget?

The CHAIRMAN. What did you say, sir?

Dr. NOURSE. I asked if a machine could forget.

Dr. BUSH. Not in the way that we forget.

Senator O'MAHONEY. That is a great human quality, which is not always automatic, I should say.

Dr. BUSH. I think I should point out a difference which is very important. The machine memory is far more precise. It is far more enduring. It does not fail, but it is by no means as extensive as the human brain. It is more precise, therefore, and makes an excellent supplement, but it can by no means do the marvelous things that the human brain can do.

Senator O'MAHONEY. When I spoke of this, I was thinking of the experience that almost everybody in our age bracket may have. You have heard people say "Well, his name is on the tip of my tongue, but I just can't remember," and then after a little while, through association or something, it will come. Now, the machine doesn't conduct any such search as the human brain?

Dr. BUSH. It doesn't do it the same way, Senator. You have brought out an exceedingly interesting point. The human brain, when it goes searching for a piece of its memory, does so by following trails of association. It remembers one thing, it passes from that to another, and finally, by following such a trail, it is likely to find the thing that it is looking for, and that is why sometimes you find that you follow a trail part way and can't get the end result at once.

The machine doesn't do that same thing of following trails. The machine in general surveys a whole area, a whole set of records, and picks out by some code the things that it is looking for.

Senator O'MAHONEY. That is because the man who built it gave it the automatic devices which allow it to go on these trails, but in the human case it is an exercise of the will, which the machine does not have.

Dr. BUSH. Quite right. There is another thing I would like to bring out. The machine is less facile because man has not yet been sufficiently clever, sufficiently ingenious to search in the way that nature does. Nature learned to do it by some process that we can't understand, in a marvelous fashion, and in that respect, the human brain cuts rings around any machine that has ever been built. I think someday machines will be built that operate by association, but it is not done today. I once wrote an article on this matter.

Senator O'MAHONEY. Machines by association, would you say?

Dr. BUSH. I wrote an article on this subject at one time that I think you will find of interest. I will be glad to send it to you. It is called The MEMEX. It was in the Atlantic Monthly, just after the war. It is on this very point.

Senator O'MAHONEY. I am glad you called it to my attention. I remember the article.

Dr. BUSH. Shall I proceed, sir?

The CHAIRMAN. Yes, sir.

Dr. BUSH. When a change of process occurs, men are forced to learn new skills, and at times to move their homes and seek other work. If the change occurs gradually, the distress may be minimized, and in fact in some cases, as is shown by Mr. Phalen in connection with dialing of telephones, and also by Mr. Brunetti, it may be essentially absent. But here is a central problem, of preventing our industrial evolution from doing harm to the individual, and I am happy that this group of papers here presented has thrown much light upon it, and brought out ways in which the distress may be reduced or offset.

There is another phase of the trend, which is part of the problem of readjustment of individuals. The introduction of automation upgrades skills. It takes far more skill to build and maintain a complex device, than merely to feed a machine. When the readjustment occurs in such a way that an individual increases his own skills, by training as the change occurs, there is a benefit all around. He earns more, and can command a higher income, the public gets more of a product and at less overall cost, and interesting work replaces dull monotony. But there are those who cannot learn new skills, who have in fact strict limitations on their value to society because of physical or mental limitations.

We certainly do not wish to just push such men into idleness, and dependence on the state. In spite of all that has been written, about the Garden of Eden and otherwise, men in general are truly happy only when they are working, but not too much, and on work which they believe is worth doing. Every time that technological change increases the skill, and the income, of an individual there is a social gain. Every time, in my opinion, that it pushes a man aside, because he is too old or too little endowed by nature to learn new skills, there is a social loss.

This would be true even if pensions, severance pay, unemployment benefits insured him a decent living. Someone in the course of these hearings intimated that a man might be considered old at 45. In my opinion, youngsters of 45 are just getting started. But, seriously, I feel that there here resides one of the most difficult problems. As technological change occurs I feel strongly that there is a responsibility, shared by employers, unions, and Government, to insure as far as possible that individuals are retrained or shifted without heavy burdens upon themselves, and that, moreover, every man willing and able to work has the opportunity to do so, and is not prematurely put on the shelf.

Thus there are serious problems in the advance of automation. I do not believe it is going to run wild and transform our civilization overnight. I know that, properly handled, it can confer further benefits upon us all, in a higher standard of living and in greater leisure. But I trust also that the harm it can do, when unwisely pushed, will have equal consideration with its advantages. These hearings have certainly been a step in that direction.

There is no doubt that since the war we have seen a great surge forward in this regard and it is interesting to examine the reasons for this. Without doubt there is a fad aspect to some of the present interest in automation; individuals are plunging into it because it is the fashion of the times, and it has become talked about a great deal because someone gave it a fancy name.

But quite aside from this there have been real changes that have increased the possibilities of rendering processes automatic. From a broad standpoint the great application of science to practical matters, started during the war and carried on at a high pitch ever since, has carried with it and increased the application of a complex technology in all areas of production.

Then, too, there has been the advent of many new devices and instruments and, more important, there are a host of young men who understand this gadgetry and know how to use it. With this we have notably a lowered cost of performing some of the individual operations which are involved in all systems of control. But above everything else, I believe we have a factor that is not ordinarily appreciated. When I was a young man one could make a complex device, but it was a far different thing to make it continue to run. Today we have something new among us which we can call reliable complexity. No longer is it true that merely because a device is exceedingly complex one need expect it to be temperamental and out of order. Let me give you an example.

Some hundred years ago Babbage tried to make a very comprehensive calculating machine. He had many of the ideas that are involved in present machines of this type and he was exceedingly ingenious. Moreover, he was generally supported in his endeavors, which was unusual. Nevertheless he failed, and merely produced a pile of junk and a few exhibits in museums. Many years later I worked in this same field and by then it had become possible to accomplish something, for the cost of making the devices had become lower and, more important, the various units that were available had become relatively reliable. Today we have exceedingly complex calculating devices entering not only into scientific work, but into industrial work of all sorts. Dr. Burgess has given you an example of one of these which is performing important calculations in the Census Bureau. The present digital machine is complex beyond anything that could possibly have been anticipated a generation ago. Yet it is expected to operate day after day with relatively few failures. There are new ideas involved, of course, but there are also new and very versatile devices that can be thus employed. The principal point is we have learned to do these complex things at reasonable cost and reliably.

Senator O'MAHONEY. May I interrupt again, Doctor?

Dr. BUSH. Yes, sir.

Senator O'MAHONEY. Returning the point where you discuss the responsibility to be shared by employers, by unions and by Government, to provide for retraining I was reminded of an incident that took place during the TNEC hearings. The occasion was the examination of the effect on employment of a continuous steel or rolling mill, which took the place of the hand mill.

I had occasion shortly after this hearing to go to a university or a college in the western part of Pennsylvania to talk about some of the current public affairs at the time, and I passed through the town of New Castle, which was as dead as a doornail, almost. New Castle had been built upon the hand mill. The new mill killed that town economically. Little businesses of the town, corner grocery store, haberdasherer, druggist, and all the stores you find on Main Street, no longer had any consumers or purchasers. The witness who appeared on the stand before our committee was a husky man. He wasn't worn out. He wasn't broken down. He may have been 45 or a little bit more, but his family were in this town of New Castle. There was nothing he could do. The 45 years behind him were the 45 years of training, so that we have some difficulty when we look at the problem of retaining a man who has lived 45 years of his life, tied to a particular calling, which in itself was tied to a machine, which in turn has become outmoded, so it becomes a very great humanitarian problem.

A man can't go out and learn a new calling with anything like the expertness which he had in the calling which technological progress has destroyed.

Dr. BUSH. I have no sympathy, Senator, with some of those who say that technological progress can go on and change can go on, and there will be distress that is worth worrying about. There will be, and technological change can cause local and temporary disruption, and it can injure careers and cause distress to individuals. This is a very serious problem which I think no really honest minded man can ignore. And it is a very difficut one.

Now I have a good deal more optimism in regard to the possibility of retraining individuals than I think many men have, if they are given the opportunity, and there lies the difficulty, of course, in the instance that you gave. But I have found that as I pass through industry, I am far more disturbed by men who are doing work where they are not using their full talents or their full possibilities, than I am by the men who are pushed beyond their capabilities.

I believe that men have far more resiliency than is generally recognized, and this calls for better training programs.

Now, in a single industry, if it is guided by wise men who consider, not merely the matter of profits, but all of the humanitarian aspects of the subject as well, we can have technological change without distress—and it has been done and done well, and you have instances of it presented to you here. But it is an entirely different thing when you have a factory in a small town and a management that has no great amount of sense in any way, and the factory folds up, and leaves in distress individuals who were working in the factory, small businesses, and so forth. We have no solution to that.

It doesn't form a solution to keep an obsolete, inefficient factory operating. Unemployment compensation goes part way toward helping out, but we have no overall solution as yet in our industrial civilization for that problem which you bring up, and I simply want to emphasize, Senator, that I certainly do not minimize the importance of the problem. I think it will take great wisdom, discretion and patience to get even a partial solution.

Senator O'MAHONEY. In view of the fact that you have prepared for the Committee on Patents some information dealing with the principal subjects, it occurs to me to mention for the record here that one of the possibilities that we have developed in the work of that committee, so far as we have gone, is this: That factories which are no longer useful for the purpose for which they were originally built, or factories which were constructed for the purpose of producing a seasonal commodity, could well be utilized by new inventions for the production of other commodities, which would in turn maintain continuous employment for the workers who would otherwise be displaced, and maintain continuous purchasing power for the community in which the factories were located.

Dr. BUSH. You are quite right, and you have put your finger on a very important point. If we have in this country the continual advent of new, small, aggressive companies, then if there is such an instance as you illustrate, where a factory shuts down and leaves skilled help and a good neighborhood, some small outfit will soon move in to take advantage of it, and this is one factor offsetting the difficult problem that you spoke of.

I had something to say about that in the statement that I submitted to your Committee on Patents, and I have a word or two on it here, for I feel strongly that one of the things that we need to pay attention to is to be sure that there are no obstacles artificially thrown in the way of the advent of new, small, aggressive industrial units, independent, able to pick their own locations, able to survive in the presence of large industrial units, and make a profit.

Senator O'MAHONEY. Thank you very much.

Dr. BUSH. I was just making the point that we can do things at reasonable cost and reliably.

One could give many examples of this point—that the advent of a particular mechanism often is dependent upon developments elsewhere, and waits until these appear. Let me give you a fanciful example. Suppose, 50 years ago, that someone had proposed making a device which would cause an automobile to follow a white line down the middle of the road, automatically and even if the driver fell asleep, in much the manner that a chicken can be caused to follow a chalk line on the floor. He would have been laughed at, and his idea would have been called preposterous.

So it would have been then. But suppose someone called for such a device today, and was willing to pay for it, leaving aside the question of whether it would actually be of any genuine use whatever. Any number of concerns would stand ready to contract to build it.

No real invention would be required. There are thousands of young men in the country to whom the design of such a device would be a pleasure. They would simply take off the shelf some photocells, thermionic tubes, servo mechanisms, relays, and if urged they would build what they would call a breadboard model, and it would work. The point is that the presence of a host of versatile, cheap, reliable gadgets, and the presence of men who understand fully all their queer ways, has rendered the building of automatic devices almost straightforward and routine. It is no longer a question of whether they can be built, it is rather a question of whether they are worth building.

But it would be a mistake to assume that the greatest result of the war, from the standpoint of the impulse it gave to the application of science and the perfection of techniques, lies in the appearance of increased emphasis on automation. The war showed, very dramatically, that concentrated application of science could produce results, in the form of radar, guided missiles, atomic bombs. As a result we now have great programs of research in many fields. More automation is one result.

But we have new fibers, new plastics, and as a result a whole new industry. We have the electronics industry, with thermionic tubes, transistors, phosphors, and their applications in radio, radar, television, and many other devices. We have greatly extended synthetic organic chemistry, with results, for one important aspect, in improved products in the hands of medical men with which to cure our ills. We have atomic power in the offing, we may have also solar power. The increase in automation is important in our lives, but it is only one factor among many in our present industrial progress.

Now there are two principal objects whenever one turns to the problem of rendering automatic a process that was previously manually controlled at many points. The principal one of these is, of course, to lower the costs of production. But there is also a second object which should not be lost sight of. Automation is often employed to increase reliability. The automatic substation of my youth was installed not because of decreased costs necessarily, for it may have replaced only one substation operator and the labor in building the very complicated substation was considerable, but it was installed because the machinery always did what it was told to do and a human operator often made mistakes, and because mistakes could be very expensive in customer relations as well as in the cost of repairs.

Much of this also applies to the modern oil refinery. I do not know where one would come out if he could summarize the net labor cost per unit of production of the old and the new types of refinery, including all costs of construction as well as of operation; I feel that undoubtedly the costs are thus lowered. But the lowering of cost does not come about primarily in my opinion by merely eliminating some of the operating personnel. It comes about because a refinery controlled at a central place by a group of men who have completely accurate and complete information before them at all times of the entire status of every unit in the refinery can avoid costly errors in operation and can keep the machinery interrelated in an optimum manner.

On the other hand I would lke to emphasize that automation is by no means a cure-all as I fear it is sometimes regarded. I remember not long ago seeing a factory assembly line that had been erected at a very considerable cost and that joined together in a single unit about 10 operations that had previously been separate, and this had rendered the whole procedure automatic. But each of these units had had an incomplete period of shakedown so that their average outages may have been as high as 10 percent of the time.

Naturally when the 10 of them were connected in series the operation was out nearly all of the time and completely a failure. There is no doubt that properly applied automation may decrease the net labor cost per unit, even when all costs are taken into account. It may at the same time increase the total labor going into a given product provided the demand is sufficiently flexible so that decreased costs of production become reflected into greater output. But every individual instance requires close analysis from this standpoint and no generalizations in regard to costs are warranted.

On the other hand, automation does definitely shift the nature of the work being done. Unskilled or semiskilled labor devoted to merely feeding and manipulating a machine is often replaced by the highly skilled labor that is necessary to build the automatic devices which replace men, to install them, and keep them in operation.

In this connection let me speak of two kinds of automation, one of which I think is usually beneficial and the other is not.

When automation tends to increase skills, and calls for human judgment, then it can raise the self-respect of the men who build and use it. But I hope we will outgrow the half-baked sort of automation which turns a man into a machine feeder, an automaton, merely an adjunct to the machine.

In saying this I do not lose sight of the fact that we have many among us who are incapable of more than exceedingly simple performance. And I certainly do not wish to see changes which would deprive them of the opportunity to render their service in their humble ways. But I also feel that we sometimes overemphasize this point, and that there are very few men indeed who are not capable of learning to do more complicated and useful skills, if they are willing to learn, if they are encouraged to, and if the full cost of learning is shared by the employers and unions.

I do not like assembly lines as they have often been built and used. I mean the type of assembly where a conveyor moves pieces past a group of men who perform operations on them as they go, putting in screws and the like. The reason I do not like them is because I do no like to see machines bossing men.

Also it seems to me that, if a small bit of ingenuity can construct such a line, a really admirable exercise of ingenuity could replace all the dull manual operations with a bit more machinery and make the whole thing automatic. This is, indeed, being done today. Then I like it, when viewed from this standpoint, for then the men boss the machine again, keep it in operation, correct its faults, tell it how fast to operate, and exactly what to make. Full automation often has its undesirable features no doubt, but, from this point of view, it is certainly preferable to one that goes halfway.

Technological change is not a new thing, it is very old. And automation is just one phase of technological change. When I was a young engineer I studied automatic substations, automatic block signals on the railroads, automatic telephone apparatus. Senator

Flanders has told of a very ingenious individual who introduced automatic assembly machinery in the Waltham watch factory back in the nineties. Mr. Brunetti has pointed out that there was an automatic flour mill in 1784. What is new is an accelerated pace in the application of new techniques in industry. And this is a part of a very important general movement, namely the planned application of scientific results in an economic manner for the increase of man's physical well-being.

Another thing that automation does which is to me exceedingly interesting is to decrease the flexibility of a given industrial production operation, and thus to increase the costs of a changeover. Hence the more extreme forms of automation are applicable only when a given product or a given design is going to be made in large quantities and for a very considerable period. Thus one would expect extremes of automation to occur in large industrial units and this is indeed the case. But the fact that flexibility is decreased is to me a very interesting matter. For the mere presence of automation is producing in this country opportunity for small industrial units to prosper in a way that I feel is very healthy from the standpoint of our whole industrial situation.

During the war I had the privilege of working with a very large number of young scientists and engineers. Many of these men were thrown out of their grooves by the war and at the end of the war did not reenter the industrial system in the old manner. A surprising number started new small businesses all over the country. These were very often centered about the making of a new instrument or device which had a special use in a relatively limited market but on which a reasonable profit could be made.

Without doubt this trend toward the introduction of new industrial units has been furthered by military purchases and military development. But it has also been helped greatly by the trend toward automation, for many of these small companies are making apparatus for that purpose, mechanical or electronic.

They can prosper in fields where there are large, well-managed companies operating primarily for the reason that they are exceedingly flexible, they can get close to their customers and meet their needs intelligently, and they can change rapidly with the times and the trends.

The point that I wish to make is that if large manufacturing companies turn to automation in extreme form, they thereby not only make a market for small companies of this sort but they also increase their own rigidity and render it more possible for the small industrial unit to prosper by reason of its inherent flexibility. This seems to me an important point, for I have long felt that our primary reliance against undue concentration of industry in this country lies in the continued advent of new small, aggressive industrial units. Thus automation may have some effects that tend to increase the size and relative proportion of production of large units, but it also has important effects in just the other direction.

We are interested in what may be the future of automation, that is, what the limits may be to its application. There are many instances in industry, I feel sure, where a net decrease in cost is present on the introduction of automation even if one includes the cost of inevitable changeovers. But this is by no means generally true. We know, for example, that automation in the automobile industry, which has proceeded to a very notable extent, has indeed rendered the change of models a very expensive affair. But I feel that entirely apart from the question of whether or not automation is in any particular instance warranted from the cost standpoint there is another limit to the extent to which it may be applied. This lies in the supply of a sufficient number of individuals who are so highly skilled that they can build and apply complex devices and keep them running successfully.

We already have a shortage in this country of skilled men of various sorts. We also have a shortage of engineers and scientists. And not enough men are entering these fields. It has been brought out in these hearings that Russia is in some ways doing a better job in this regard than we are; they are certainly training more scientists and engineers. And, from the discussions I have had with Dr. Homer Dodge, who has recently been in Russia, I believe their teaching is especially well done.

In Russia if they find a particularly bright youngster he enters on a long career of study to become a scientist or engineer. They give him periodic stiff examinations, and if he flunks them he is promptly put in the army. In this country, in spite of all our admirable systems of scholarships and the like, the bright youngster may have to pay most of his own way, and it may not be possible for him to do so. I do not advocate the Russian system by any means; there are lots of things wrong with it. But we need to correct 1 or 2 things ourselves. We should make it possible for really outstanding youngsters, chaps of extraordinary talent, to proceed in education just as far as their talents will carry them. We should do this because they will thus be able to serve society well. And we need to come to the realization that, when a young man is thus making real progress on a career which will enable him to serve his fellows well, he is doing his part, and we should not seriously interrupt his career for military training. Please do not misunderstand me, I recognize the need of military training, and I believe it is a good thing for youth when well conducted. But I also believe we have not yet solved the problem of the highly talented youngsters among us.

There is another point on this matter of education, on which I could talk at length, but which is after all only one phase of the subject before this committee. There are numerous ways of obtaining an education in this country. Not all of the capable engineers and scientists are the product of formal schemes of education. I have known highly skilled engineers who never finished high school.

The needs of industry for men of higher skills will, I trust, further many procedures by which such men can be trained. Mr. Brunetti and others have told us of some of these. There is nothing that can be done to advance this country's welfare more important than to insure that every individual who has the ambition to study and to improve his skills, finds the opportunity to do so.

There may indeed be another limitation in many instances to the extent to which automation may be usefully applied if extreme automatic production leads to saturation of individual markets, but certainly I would leave this matter for Dr. Nourse's comments. I do as an engineer have to consider the economic aspects of many matters, but that does not indicate that I am an economist.

Now I stated above two primary reasons for automation. But there is another object which is not often emphasized. It seems to me important, not from the standpoint of the individual industry alone, but from the broader standpoint of society as a whole.

If a man can be transferred from monotonous to interesting work there is a social gain. Whenever a man is simply a part of a machine, pulling levers, inserting materials, or the like, but not exercising human judgment, it is well worth while to turn his function over to an automatic device if he can be employed to build that device, install it, and service it, provided the changeover can come so gradually as to minimize the inevitable temporary local disruption involved.

But I am always happier when I go through an industrial plant if I see men working on complex machines where they are quite obviously exercising their intelligence, their ingenuity, and their judgment to the utmost, and I always feel that there is something wrong with our system if I see a fellow human being performing an operation which calls for nothing more than his presence and his manual operations.

But there is also another aspect of automation which is closely allied with this, and that is to abolish jobs that are inherently dangerous and burdensome and replace them by jobs that are not. If we could have automatic means by which we could get our coal and our minerals out of the earth without calling upon any man to work underground, or at least calling for a relatively few thus to work under dangerous and disagreeable conditions, I would be all for it, provided, of course, that those who now mine could find opportunity to earn as much, or more, to contribute as fully to our prosperity, in other ways and above ground. Throughout industry there are jobs of this sort with hot metals, dangerous chamicals, and the like. Entirely apart from the cost aspects, I hope and trust that the further spread of automation will bring us to the time when we call on far fewer of our fellow citizens to do dangerous or disagreeable things for our benefit.

Mr. Chairman, you have had an exceedingly interesting set of hearings. I can by no means summarize them, even from the engineering standpoint. But I have come to certain conclusions. Technological change will certainly go forward, and automation as a part of it. In the long run it can greatly raise our standard of living, and give us greater comfort and more leisure. With it come problems, as has always been the case with technological change, due to local or temporary disruption. These problems center, in my mind, about the individual. It is incumbent upon us to so guide the change that an absolute minimum of injustice is done to any individual, and so that the social benefits far outweigh the distress that may be caused. This involves serious thought to problems of retraining, relocating, and the like, to the avoidance of blighted areas, to our whole system of education. I feel that the papers here presented have brought many of these problems into clear relief. I believe we have been shown examples of companies who have exercised real wisdom in this connection.

Moreover, I believe they can all be solved by clear thinking, and collaboration between men in industry, in labor unions, and in Government. We have done pretty well in solving our problems in the past. I believe we can do still better in the future.

The CHAIRMAN. Thank you very much, Dr. Bush.

Now, if you will remain, please, we feel that we are very fortunate this morning in having the privilege of getting the information from two of our great American citizens, certainly experts in their respective fields, and we want to take the maximum advantage of it. When Dr. Nourse has concluded his statement, if you gentlemen care to ask each other questions, and provoke the discussion even more and bring out more points, it will certainly be helpful to the committee.

Dr. BUSH. Certainly I will enjoy that, Mr. Chairman.

Dr. NOURSE. I will, too.

The CHAIRMAN. Dr. Nourse, we, of course, are glad to hear from you.

STATEMENT OF DR. EDWIN G. NOURSE, FORMER CHAIRMAN, COUNCIL OF ECONOMIC ADVISERS

Dr. NOURSE. Mr. Chairman, your subcommittee has had presented to it a detailed and somewhat diverse description of the recent technological developments that pass under the label "automation." It has been given a no less extensive and even more divergent portrayal of the impacts that business executives, labor officials, and economists anticipate that these technological developments will have on our economy. Anyone listening to or reading all this testimony might well despair of finding enough agreement or common understanding to be of much help to you. From my following of these hearings and some other conferences on the same subject, however, I feel that several rather significant conclusions are warranted. Your committee is interested primarily in economic impacts, "foreseeable trends" in technological development that will help or hinder the attainment of "maximum production, employment, and purchasing power." I believe that these technological premises for our economic reasoning and policymaking are becoming reasonably clear.

From Vice President Davis, of the Ford Motor Co. on the first day to Dr. Bush, a scientist and engineer of extraordinary experience, academic, industrial, and governmental, this morning you have had traced for you the story of automation as mechanization. From this aspect it consists in a large and growing array of mechanical and electronic devices that give producers new machines for doing new things or old things better and equipping old machines with new gadgets. The essential feature of this new step in mechanization is the application of electronics to the control of mechanical and chemical processes. The mechanical brain or electronic computer is the central feature of this development, and the practical result is the substitution of mechanical for manual controls at many points in the physical process of production. As has repeatedly been pointed out, these mechanical controls also make it possible to do things we could not do at all by manual methods, notably the production of atomic power.

FOUR ASPECTS OF AUTOMATION

In a very able and illuminating paper in the opening session of these hearings, professor Buckingham, of the Georgia Institute of Technology, differentiated four phases of what is labeled "automation"; namely, mechanization, feedback, continuous process, and rationalization. I am somewhat bothered by having "continuous process" put third in this sequence instead of second, because continuous process has been a part of the story of mechanization from early flour-milling through meatpacking to the automobile assembly line, where gravity, or steam, or electric power gave continuity but where manual controls were still heavily relied on.

The real change came when we passed from this kind of continuous-process mechanization to that in which electronic devices make it possible to dispense to considerable extent with the mental element in manual control and to use the feedback principle extensively. Under this principle, electronic mechanisms make it possible to conduct more elaborate, more economical, and more precise continuous-production operations because the outcome of the process controls the process itself, starting, altering, or stopping it so as to make it produce a desired result. This should dispose of the cliché that automation is nothing new, just more mechanization. It has its roots in mechanization, to be sure, but something new was added when electronic devices made possible the widespread application of the feedback principle.

The three earlier phases of industrialism, mechanization, continuous process, and rationalization, all continue but have been given a new dimension. When we introduce this word "rationalization" we pass over from the primarily technological to the primarily economic meanings of automation, though, of course, the two are interrelated. Though Professor Buckingham included this area of discussion in his outline statement he did not develop it very far. I am therefore taking up where he left off.

He said:

> Rationalization in a production system means that the entire process from the raw material to the finished product is carefully analyzed so that every operation can be designed to contribute in the most efficient way to the achievement of clearly enunciated goals of the enterprise * * * The scientific, rationalist philosophy takes on numerous new implications when it can be implemented by modern electronic machinery.

In this aspect also automation is not something altogether new. It is essentially a continuation of the scientific management movement which took shape about 50 years ago. Indeed that movement toward cost-reduction or efficiency increase was even then often called rationalization, particularly in European comment. It gave rise to much agitation about technological unemployment, and to the cult of technocracy in the period between World War I and World War II. It led also to the movement toward economic and social planning. Whereas scientific management was directed toward rationalization of the operations of the individual plant or company, national economic planning had as its goal the rationalization of the operation of the whole economy. The point I want to make here is that this new development of electronic computers and controls, and this enlarged concept of continuous process makes contributions to the objectives of national economic efficiency set out in Employment Act.

FROM TECHNOLOGY TO ECONOMICS

Let us look for a moment at continuous process, as applied to the economy. A very simple model of a stable free-enterprise economy would show companies and individual producers buying their materials, their capital, labor, and other productive resources in free markets, turning them into finished goods which are distributed to consumers and other users at prices which fall within their purchasing power and which yield returns to the producers which enable them to maintain, improve, and expand their facilities in step with growing population and advancing techniques and provide the owners with residual profits adequate to compensate risk and provide incentive for continuing the process, including expansion and technological progress, at full tide.

This economic process is carried on through an elaborate system of price-and-income relations largely arrived at through market bargains, but with participation of Government at a few places where we the people have decided that such participation is needed or beneficial. These price-and-income relations have been working out so well for the last decade that we have had high and rising prosperity. The issue which automation now raises is this: Will the coming of automation alter present economic relations in such ways as to disturb these favorable conditions, or will our business system be able to translate these technological improvements fully and promptly into still greater general prosperity and higher standards of living? It is evident that it will change wage income both by number of jobs—some places up and some places down—and by wage rates upgraded here and downgraded there. It will obsolete some capital equipment and make important demands for new capital equipment. It will affect until costs for some products, but not all; prices in some markets, not in others; profits and dividends, tax yields, and public spending. All those will be affected in the economy by the change in our technology.

The preponderant attitude of business executives on the issue of automation seems to be:

> **This is simply the current phase of the age-old process of mechanization; the historic record shows that each successive step in mechanization has created more jobs than it destroyed and has been followed by the necessary price and investment adjustments. We are confident that this will prove true in the present instance.**

As a long-run prospect, I believe we are justified in accepting this evaluation. But on so sweeping a proposition we need to study the fine print rather than just taking the boldfaced captions. While the historical and statistical record does show a consistent uptrend in general production and average real income or well-being along with technological progress, there have been severe short-run dislocations, local catastrophes, and painful readjustments for both employers and employees.

In contrast to the preponderant attitude of business executives, labor-union officials have been outspokenly concerned about the economic impact of automation on the well-being of the mass of worker-consumers in the years immediately ahead. Some among them, to be sure, simply follow blind instinct and fight any laborsaving change. But top labor leadership began early to talk in terms of "the challenge of automation." This challenge they state somewhat as follows—at least three labor spokesmen in your hearings have made very clear statements of this very sort:

> **The guiding purpose of labor organization is to raise the level of well-being for the working masses. This demands maximum production and economic expansion. Automation, as the current phase of technological and managerial**

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development, is designed to promote this end, and organized labor welcomes it and seeks to cooperate in its growth. But we believe that much study is needed by all parties if the gains are to be made as large and as steady as possible and the temporary dislocations and local burdens or losses made as small as possible and most equitably shared.

With this view I find myself in accord rather than with the idea that the problem will take care of itself or be disposed of automatically by the invisible hand of free enterprise.

TECHNOLOGY IS INDIVISIBLE

Here I want to make three points: (1) That automation is only one inseparable part of the larger problem of technological progress; (2) that the application of our advancing technology to the ever-better satisfaction of human wants goes forward through a continuous flow of money relations essentially like the "continuous process" of physical production in an automated factory; (3) that the economic problems posed by this technological advance can be solved only by a combination of competitive pressure, business statesmanship, and constructive public policy.

As to the first point, there seems to be a considerable tendency to blame—or credit—automation for impacts on the economy that stem primarily from other factors in our advancing technology. This is misleading, but at the same time it is quite impossible to separate these several sources of increased productivity from one another and to measure and deal with each of them separately. We are not, in fact, confronted by a specific economic problem of automation but with a broad total problem of trying to capture the values of higher productivity put within our reach by scientific progress and avoiding either nonuse or misuse of these potentialities. We are all aware that the technology that gives us our present high level of productivity includes the internal combustion engine and jet propulsion; the newer metallurgy, including light metals and a great range of alloys; synthetic chemistry, with its versatile development of plastics; radiology and atomic fission. Automation is only a way of increasing this varied and highly productive technology. It happens at the moment to have stolen the spotlight, but we shall have to deal with the problem of assimilating the total technology into our economic institutions and practices.

We have not done this step by step as the successive technological changes took place, and hence the accumulated problems have become a cause of concern and possible friction. Fortunately, automation itself furnishes us some tools for tackling the problem of assimilating technological progress into economic progress, both an intellectual tool in the concept of "continuous process" or integration, or rationalization, and a mechanical tool in the device of the electronic computer.

INTEGRATION OF THE ECONOMIC PROCESS

When businessmen or others say that technological progress is good, per se, and that it takes care of its own economic problems, they invoke a simple logic of the free-enterprise economy. The entrepreneuer seeks profit by adopting a device for raising efficiency. This lowers cost. Price falls proportionately and thus broadens the market. This restores the number of jobs or even increases them and raises the level of living or real incomes. This comfortable formula presupposes a state of complete and perfect competition in a quite simple economic environment with great mobility of labor, both geographical and occupational. But these are not the conditions of today's industrial society, with large corporations and administered prices; with large unions and complicated term contracts covering wages, working conditions, and "security"; with complex tax structures, credit systems, and extensive Government employment and procurement. The smooth and beneficent assimilation of sharp and rapid technological change has to be effectuated through intelligent and even generous policies painstakingly arrived at by administrative agencies, private and public.

It is of the essence of the automation concept and program that it integrates the several parts of a complex total process so that its successive or related steps shall mesh smoothly together without conflict, lost motion, or lost time. As an economist, I am moved to stress the fact that the operational flow of our modern industrial system is not merely a matter of the physical movement of material objects from their native state through the processes of extraction, fabrication, and delivery as finished—often highly complex—products. It involves also the flow of price-and-income relationships that furnish purchasing power to consumers—individuals, business concerns, and Government procurement agencies—as well as capital formation out of profits and savings, and finally incentives to enterprisers and to workers of all grades to prepare themselves for and apply themselves to the kinds of activity that the character of our technology makes possible and requires.

I take it to be my assignment in these hearings to deal in very broad and summary fashion with the question how what we call automation affects these relationships. Are we aware of what are the components of this operational flow and are we integrating them so intelligently as to attain the maximum production that is the major goal set up in the Employment Act under whose mandate this committee operates?

Time does not permit a systematic analysis of these large questions, but I shall undertake to hit a few high spots which will illustrate some of the practical problems in the integration of wage structure, profit rates, price policy, and investment practice. I shall do this in terms of short-run "foreseeable trends." My major premise is that we are now in a critical situation which might, hopefully, be described as pregnant or, apprehensively, as explosive.

Against the complacent picture presented by some witnesses at these hearings, let us put the actual sequence of economic developments in postwar United States. Technology, with infant but growing automation, has been put to full use under conditions of extraordinarily high and sustained demand, public and private. Labor, viewing this unparalleled rise in productivity, has sought to capture the largest possible share in the form of successive rounds of widespread wage increases in basic rates, escalation formulas, and fringe benefits. As the unit cost of labor went up, management sought to maintain or improve its earning position by raising prices and/or by introducing labor-saving machines and administration. The first solution of manage-

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ment's problem, that is, price raising, has been facilitated by our elastic monetary system, and we are now drifting along on a Sybaritic course of mild inflation as a way of life. The second solution of management's problem of meeting labor's wage demands has accelerated piecemeal mechanization, yesterday's infant "scientific management," today's adolescent automation.

Adolescence is always a stage of storm and stress, and this is no less true of this problem child of industry than it is of the teen-age kid. The badly adjusted youth has part of his psyche ahead of other parts, and I fear that this is also true of automated industry. I strongly suspect that we have already built up at many spots a productive capacity in excess of the absorptive capacity of the forthcoming market under city and country income patterns that have been provided, and employment patterns that will result from this automated operation. We are told on impressive authority that we have not been making adequate capital provision for reequipping industry in step with the progress of technology. This is probably true if it means making full application of electronic devices and Univac controls generally throughout our industrial plant. But we have not yet demonstrated our ability to adjust the actual market of 1956–57, and later years, to the productivity of the production lines we have already modernized. They have not yet come to full production, but as they do we see incipient unemployment appearing.[1]

Since that, along with slight credit tightening, will tend in some degree to restrict the market appetite, it seems likely that next year will see a still further enlarged output somewhat out of balance with this reduced demand. Suggestions have been made that balance could be restored by lowering prices or by cutting the workweek. Both processes take time and present their own difficulties. Meanwhile, the current trend is toward higher prices, reflecting wage advances already negotiated.

Let us get down to cases. Last summer several very complicated and quite novel wage contracts were concluded in two basic industries, automobiles and steel. In effect, the United Automobile Workers and the United Steelworkers put a punched card into the control mechanism of our national economic process that instructed it to divert income over the next few years to specific groups of workers at specified rates. Almost simultaneously the steel executives instructed the continuous-process money mechanism to channel funds to them at a higher rate than formerly. The automobile executives waited several months before they raised prices. Now, both of these steps were attempts to plan or rationalize the economic process to make it work better for particular groups. The unions argued that more purchasing power must be diverted to consumers if a growing product is to be sold, and that this income could be drawn off from company treasuries without harm to the industry. The companies argued that they could not pay higher wages, expand plant, and improve technology unless they could get more for their product and that their customers were able to pay these higher prices while still maintaining or enlarging the volume of sales.

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[1] It is well to remember that not all years are equally propitious for the reabsorption of workers displaced by technological changes, nor is the situation the same in all industries. Several witnesses in these hearings have presented evidence that they have created new jobs faster than old jobs have been displaced by technological changes. This is conspicuously true in the telephone, television, and other branches of the electric and electronics industries, where deman has been very elastic. It has not been true in farming and in railroading, where demand has been stationary or declining—even in the very prosperous years we have been experiencing.

Nor can the problem be left entirely to the curative or preventive powers of population growth, which is one of the chief reliances of the economic faith healers. The notion that the growth of total population in the next decade will far outstrip the growth of the labor force, which was launched by a writer of popular economics, is contradicted by recent analyses of the U. S. Bureau of the Census.

I am not suggesting any judgment as to the correctness of the setting of these particular controls on the economic process, but simply calling attention to the well-known fact that once these persons in authority in administrative areas, private or public, preset any one of these control devices on our money-flow system, they—and many other groups in the economy—have to abide by the inevitable consequences of these interventions in the continuous process, or else revise the setting and give more workable instructions to the mechanism.

A second illustration could be drawn from agriculture. We installed some gadgets to stimulate production under war and early postwar conditions of domestic and foreign demand. As technology improved in agriculture, mechanization was accomplished and demand fell off, and we have been unable to change the settings on the control device to bring this part of the process in step with other parts. We go on with surplus plant, surplus workers, and surplus product.

A third case of very basic character in the adjustment of money flows to technological conditions, and changes may be taken from the field of investment needs and tax policy. Witnesses from the field of management, and Dr. Bush this morning, have indicated that it is quite possible to invest so much in automatic installations as to entail loss rather than gain. Witnesses from labor have pointed out that automation in excess of market demand may entail idleness for some workers and waste of labor resources by the Nation.

Shifting taxes onto or off of corporations or income classes is a means of influencing these interconnected economic processes. This is high lighted for each Congress by the rival demands of the "trickle down" and the "trickle up" schools of tax policy. The point often hidden by the smoke of battle is that the optimum tempo of technological advance, investment, and productivity is not self-determined, but should be relative to the price-income structure and the spending and saving patterns of the mass of the population.

In this connection a word might be said about the ambitious proposals of a guaranteed annual wage as a means of integrating the investment and employment phases of the economic process. The analogy with depreciation accounting for capital equipment does not "jump on all fours," but the concern of the economy for the maintenance of labor efficiency and consumer power is no less vital than its concern for capital conservation and optimum growth of capital. We need much more research and carefully checked experimentation along these lines if we are to discover which revisions of current business practice will do most to incorporate technological improvements into economic gains.

The continuous-process concept should guide such studies and the use of electronic computers should facilitate the processing of the vast array of data needed for making adequate interpretation of results under different proposals. It is arguable that a closer approach to optimum rate of adoption not merely of automatic devices but of all mechanization and other technological advances would be attained if our institutions required companies to consider and provide not only for the cost to them of new equipment or processes but also for the cost to the worker resulting from such changes. Many devices other than time guaranties for wages—for instance, severance pay or reimbursement for the time lost or skills scrapped—need to be explored. One of your witnesses mentioned severance pay as one of the ways in which they were trying to deal with the problem in their industry—the telephone industry. The real question is how the incidental costs of social progress are to be distributed between private and public agencies.

I might say as to my own economic creed that I don't believe the individual needs to be carried around on a pillow. I don't believe it is desirable for the firm to appropriate the benefits of economic progress and shoulder the costs off on the worker, and I don't think the Government should be the benevolent grandmother adjusting all these relationships. As I indicated, study has to be made in this field of properly distributing the burdens.

In the course of these hearings various members of the committee and its staff have raised the question whether legislation should be recommended to deal with the problems created by so-called automation. The answer, I think, is an unqualified "No." To curb or redirect the process of scientific discovery and engineering application and the adaptations of businessmen and consumers to these changes would be utterly repugnant to the system of free enterprise and individual choice that have made our country great. Nonetheless, every time the Congress passes a money bill, every time it revises our tax structure, every time it passes a regulatory measure for price maintenance (alias "fair trade"), farm price supports (alias "parity"), or stockpiling of copper, rubber, wool, or silver, it is giving punchcard or tape instructions to some part of the continuous-flow mechanism of our economy. Public policy on all these matters should be framed in the light of the fullest possible understanding of the integrated character of the price-income structure and behavior of our economy, with an eye single to promoting "maximum production, employment, and purchasing power" for the whole people, not to serve the immediate interest of any special group.

This sort of scientific and engineering rationalization of our national affairs calls for a simply stupendous amount of grassroots data as to what is actually happening at an infinite number of spots in the economic process. That mass of data is too voluminous to be seen, classified, and evaluated by statisticians, economists, and statesmen and processed into generalizations which can guide legislators and executives, public and private, in discharging their necessary function of programing the economic process and of presetting the control mechanisms that determine the value flows throughout the economy, and thus lead to full and efficient use of our resources or to delays, wastes, or breakdowns in the mechanism.

Fortunately, the development of the electronic computer or mechanical brain makes it possible to process these vast bodies of relevant data economically and accurately, thus giving an adequate and reliable base—I want to reiterate, to give a more adequate and reliable base—on which human judgment can be exercised as to the course which economic policy and action should follow. Business concerns can use and are using such computers to analyze market capacities and responses, to calculate investment policy—such, for example, as the practicability of automating their operations—or wage policy, particularly as to pension plans or the possibilities and consequences of making annual or less-than-full-year employment guaranties. Mr. Burgess explained how two Univacs in the Census Bureau are making it possible to make more and better economic data available for the use of business and Government agencies.

Logistic problems (which are essentially business problems) during the war led to application of data-processing methods on an unexampled scale and to the subsidizing of research and experimental work on both method and equipment. The input-output project at Harvard University is designed to give us an empirical and analytical overview of the integrated operation of the whole economy. This sort of data processing is supplemented by the newer expectations and projections techniques superseding the methods of hunch, prejudice, and interest-group pressure, deductive reasoning, perhaps, which stand in the way of rationalization of our economic affairs. These methods of objective analysis of economic problems seem destined to have increasingly wide practical application in administered pricemaking, in the negotiation of national wage bargains and security plans in basic industries, and in the handling of our money-and-credit system.

It is a striking coincidence that it was during the very week of these committee hearings that the papers have been full of the news that the Federal Reserve System is inaugurating wider operative use of the technique of the flow of funds system of national accounts, which it has been developing for some 5 years.

It seems to me that the apparatus of the Council of Economic Advisers and the Joint Economic Committee is well conceived to bring methods of scientific rationalization to bear on Federal legislation and administration at all points where our rapid technological development impinges on our economic relations. I see some evidence, too, that these more scientific approaches to their practical problems are being adopted in the operative relations of economic groups—management, labor, and finance.

I think you might highlight that by the experience of last summer in the making of these wage contracts in the basic industries of automobile and steel. It seems to me that we have just seen a step in progress in the handling of labor-management relations. Wage bargaining originally was on the basis of force, and the issue was determined by which party had the greater strength, either to withhold labor from the machine process or to withhold machines from the labor force. That was on the basis of class struggle. When we moved on to peaceful collective bargaining there was introduced something of a horse-trading element, but the parties also began to rely more and more on reasoning from more correct and adequate data, rather than starting from extreme demands and minimum concessions and bargaining out to a figure near the middle.

The thing which seemed to me significant last summer was that both parties at interest recognized that there had to be a rational basis for settlement that would enable the productive process to go on without interruption. Neither one was ready to upset the applecart of general prosperity. That seems to me to be something which needs to be developed further if we are going really to use our possibilities of integrating the economic process so that the needs of the economy are served with settlements made on the basis of a wide objective approach to a mutual problem.

Of course, no amount of data and no improvement in its processing will yield final answers of industrial, commercial, or Government policy. They give the tools for value judgments rather than demonstrable answers to social problems. That is why I put as the final point in my suggestions of how we can get optimum results or maximum well-being from our rapidly advancing technology the dual need for competitive institutions backed with mutual forbearance by the parties at interest.

COMPETITION AND RESPONSIBILITY

The declaration of policy of the Employment Act set "free competitive enterprise" as a premise of its policy, and the historic argument for giving technological innovation free rein is that competition both maximizes its gains in production and distributes its benefits in purchasing power. One of the dangers of automation stems from some tendency toward rigidity, and this applies equally to concentrations of economic power in the hands of management, of labor, or of finance. The legislative recommendations of this committee should in my judgment be unremitting in their emphasis on maintaining real competition between centers of administrative control even when the operative units introduced by modern technology are necessarily large. But an optimum result depends on the mores of business above and beyond the structures set up in law. Each segment of an automatic continuous process has a built-in responsibility to every other part through its mechanical interconnections. Something comparable to this is seen in an authoritarian economy. They have built-in relationships, but in a free-enterprise system human judgment is given play at most of the important points of interrelationship. Between management and labor, between executives and prices, et cetera. Unless the responsible executives seek to integrate their operations to the prosperity of the whole economy and use the full apparatus available for gathering and processing the data relevant to policy determination, our economic process will disintegrate into wasteful struggles for individual or group short-run advantage. Much of the potential benefit of technological progress, of which automation is one particular expression, may be lost through failure to make our economic structure and practices equally scientific.

The CHAIRMAN. Thank you very much, Dr. Nourse.

Now, if you gentlemen will start out by discussing something that I consider of major importance, it will be appreciated. One of the most disturbing things that has been brought to my attention by these hearings is the fact that Russia apparently is getting ahead of us in education. I think the facts are undisputed among the witnesses that next year, 1956, we will graduate 27,000 engineers. Russia will graduate 50,000 engineers; that we will graduate about 50,000 technicians, and Russia will graduate about 32 times that number—1,600,000 technicians.

Now, if you gentlemen will give us the benefit of your thinking on how the situation can be cured from the standpoint of our country I know it will be of great help to us.

Dr. NOURSE. That is a question that I planned to ask Dr. Bush, or to pick up from some of his comments. He talks at one place about a "host of young men who understand this gadgetry and how to use it," and later he said that if a still more complicated machine was called for, "thousands of young men would be itching to build it." That seems to have a quite optimistic outlook as to technically and scientifically trained people, but at another point he expressed some reservation as to limitation of the people available to do the more complicated things which are involved. I would like to have that seeming contradiction explained. Then when Dr. Bush gets through I would like to comment on another phase of the problem of education for high production.

The CHAIRMAN. All right, Dr. Bush.

Dr. BUSH. I think there is no doubt that Russia is doing a very good job, indeed, in training its people. I have given you one aspect of it. Dr. Astin, when he testified the other day, went into the matter quite thoroughly.

They are doing good teaching. A very important aspect of that is that their teachers are respected. They are given deference in their communities. They are regarded as men of attainment. Of course, Russia simply puts the finger on a man and says to him "You are a teacher," whereas in this country we are a little likely at times to put a finger on a teacher and say "You are now an industrial employee at three times your previous salary."

I don't think a good deal of this procedure does not make much sense. I don't like the authoritative way of going about things, but it certainly has its advantages at times.

We need very much, Mr. Chairman, to raise the caliber of teaching in our elementary and secondary schools. That is an exceedingly important problem.

Now, to turn to your point, Dr. Nourse, I did say that there are a host of youngsters, and there are, that understand these gadgets and are very able to deal with them. They came to that knowledge in various ways. Some of them came through our formal system of education, and most of our engineers and scientists, of course, arrived in that way, but that is by no means the whole story. During the war, and afterwards, we have had a host of youngsters brought into contact with technical devices of various sorts, and they have learned how to operate them and to understand them on their own—taking advantage of evening school methods and apprentice courses, and so forth, but oftentimes simply on their own.

I know of one case where a man, during the war, made one of the finest pieces of progress that was made on a radar device of great importance. He was highly respected by the physicists that he was working with. He showed great ingenuity and great understanding of the complex electronics involved in the magnetron. That man's father was killed in an accident in a sawmill when the boy was age 4. He was brought up by his grandfather. He never went to school beyond elementary school. He was a physicist and an engineer, and a very good one, indeed. He had never had the benefit of formal education, but he had what it took, and he learned by himself, and so did a host of other youngsters, as the war went on and afterward.

Now, the point I want to emphasize is this: Mere summaries of what we are doing in formal education, in our high schools and colleges, is not enough. Ambitious and keen youngsters will learn in a good school or in spite of a bad one, if they are sufficiently ambitious and if they work hard. We need in this country not only a great improvement in our formal methods of education, and an expansion, but we need also to facilitate in every possible way the means by which a youngster of understanding, talent, and ambition can acquire an education, whether or not it is part of the formal process.

When we take that into account I do not believe that today we are by any means behind Russia. I think we have a host of youngsters who understand these things, and understand them very well, indeed, and are quite competent, but looking ahead to the future, if Russia keeps up her present pace, and we keep up ours, I am fearful that we may not be able to hold our position of superiority to the degree that we hold it today, and I think, therefore, we need to pay attention to all these aspects of this important matter that the chairman has brought to our attention.

Dr. NOURSE. Well, then, you do feel that some further pressure on the education of scientists and technologists is called for in view of the situation as it develops in technology?

Dr. BUSH. Yes, especially in our elementary schools and high schools throughout the country. We have high schools in this country where there isn't a man on the teaching force, or woman, either, who knows anything about science in any of its aspects, and the reason for it is when we get right down to the basic aspects of it that we have lost in this country something that we had in its early days—great respect for the man of culture who is willing to teach. In even the little red schoolhouse the teacher was a man of the community, regarded highly because he was a scholar. We have lost that, and we do not today give to these men who go into elementary schoolteaching, and who do a good job there, the recognition that they deserve.

It is not merely a matter of money. We don't pay them enough, but we do not give them the standing in the community that we used to give them.

Dr. NOURSE. There, Dr. Bush, is leading right into what I wanted to mention in this connection. He has, naturally, talked in terms of the general grounding in science, which makes young scientists who are able to go on, that makes technologists of boys who don't go beyond the level of high school, and he stressed the high school as extremely important.

The CHAIRMAN. If you will pardon me, Dr. Astin, I believe, stated yesterday that the high school was our weak point.

Dr. NOURSE. Yes, I want to reiterate that, joining in both with what Dr. Astin said and what Dr. Bush has said here. The point I want to make is this: We need not merely to have our rising generation given adequate grounding to become technologists and scientists, but we need them also to be given adequate grounding in the economic and political and social aspects of our society so that they will be able to function intelligently, and, as I said in my paper, tolerantly, in carrying out a free-enterprise system.

Three-fourths of the young people don't go on to college and yet from among those who graduate from high school we recruit people who rise to the very top places in managerial posts, the direction of industry and the officials of our labor unions and our agricultural organization officials come from that group. But they are not really trained, and the teaching staff does not know how to train them, in the social and economic and political system in which they are going to live their lives.

These remarks are something in the nature of "a commercial," perhaps, because I happen to be giving a good deal of my time at present to the work of the Joint Council on Economic Education, which is beamed exactly at that problem, of trying to raise the level of training for living in our sort of a free-enterprise system, which is given by the high schools; and toward the training of teachers so they will have an adequate frame of reference from which to deal with specific economic problems at the level of understanding and experience that the high-school student has reached by the time he gets through his senior year.

The CHAIRMAN. It is so timely, will you tell us more about your joint council? Is it a national organization or is it composed of a lot of people or a few people?

Dr. NOURSE. The joint council is something of about 6 years of operating experience. It was established as an attempt to bring the professionals in education and in economics to work with teachers and administrative officials of our schools, to accomplish this purpose of better economic understanding at the secondary school level. It is nationwide in scope. It holds summer workshops and interim in-service training during the year, running from New Hampshire and Massachusetts to California and Hawaii on the West, and from Florida and Texas on the South, to Minnesota and Washington on the North. There were 31 of these workshops held in different sections of the country last summer, and the whole philosophy is that each shall be based on a local university or college, and shall have the support of the educational authorities and the business community in which it is held.

The CHAIRMAN. I believe Mr. Ensley knows something about your workshops.

Dr. NOURSE. He has been a participant in a number of them, a very helpful participant.

Mr. ENSLEY. Well, I can testify as to the usefulness of their program within the community. Among other places, I go up to the University of West Virginia each year, and meet with high school teachers. The interesting and disturbing information that I got there this summer was that many high school teachers in that State were teaching math and science without training in these fields. Small wonder students are drifting away from taking algebra, geometry, physics, in high school, under those circumstances. So I certainly appreciate the comments of Dr. Bush and Dr. Nourse on the needs of our secondary and high schools for better teachers.

The CHAIRMAN. Mr. Moore?

Mr. MOORE. Dr. Bush, we have tended to use these words "engineers" and "scientists" and "technicians" more or less interchangeably in this hearing and say we need more of them. This is no reflection on the need for engineers, but isn't it pure chemists or physicists that we need even more than engineers?

Dr. BUSH. Idon't think it is a matter of more or less. We need all of them. Certainly in this country we have a tendency to apply things well, to be adept in applied science and engineering, and we are not similarly adept at science. Until recently we were far behind Europe in our support of basic science and in our production of basic scientific results. We derived a great deal of our basic science from Europe. Since the war we have been improving in this regard, until we are taking our place among nations as outstanding in many fields of basic science. We can't overdo this. We need more fundamental science. We need more appreciation of, and more support of, basic science.

The National Science Foundation has placed a great deal of emphasis on this point, and I think very usefully, and I think the trend has recently been in the direction of correcting our faults in this regard. But we need all kinds of pure and applied science. We need everything, all the way from pure mathematics, in the hands of the pure scientist, who cares nothing whatever about the applicability of his results, down or up, whichever way you may wish to regard it, to the applied scientist, and then to the engineer, whose task it is to apply science in an economic manner, and then, of course, through all the grades of technicians, and so forth.

Mr. MOORE. When you say we need more of all trained people, I am glad to hear you say this, because recent emphasis has been so much on this automation field that we have forgotten that we also need doctors, nurses, and, perhaps, even economists.

Dr. BUSH. Of course, I don't think you will misunderstand either of us. We are talking this morning about automation. That is largely a matter for the engineer and economist, so that we are talking from our own points of view, but don't think that we disregard the other aspects of the matter. Dr. Nourse a moment ago spoke of the need of economics in the high schools. I would like to emphasize equally the need for growing appreciation of science generally throughout our system of teaching. I would like to say at the same time that I hope the scientists in the future will be taught better than in the past and particularly better than they were taught when I was many years younger.

Dr. NOURSE. I wonder if I can bring into the discussion a question which has been asked by someone outside the hearings.

The CHAIRMAN. Certainly, sir.

Dr. NOURSE. In Business Week, making reference to the earlier hearings here, it says:

> This brought the subcommittee to a key point. Right here you might have expected that this vital question would have been asked, "Will automation be applied, excepting in time of an expanding, high-competitive economy?" Nobody asked it. Still, the significance of the rest of the subcommittee's work may rest upon getting an answer to this.

I think we should satisfy that inquiring reporter. The implication seems to be that we needn't worry, because management will simply introduce more automatic labor-and-material-saving appliances when they are required by high pressure for more production, and when they don't have that pressure automation will drop off and everything will adjust satisfactorily. I think that is a misconception.

A good many of the people who have testified here have indicated that you have a more sustained rate of growth and adaptation of these technological developments. In spite of the fact that there may be more funds with which to install additional machinery or more pressure to do so in time of prosperity, technological change will continue in times of recession also, and perhaps be accelerated because companies who are pressed because of narrow profits will turn more to the application of labor-saving and material-saving devices.

The CHAIRMAN. Are you overlooking the purchasing power angle there, Dr. Nourse?

Dr. NOURSE. You mean of companies' ability to install new automatic equipment?

The CHAIRMAN. You see, in depression, if you increase the production, you would have to have purchasing power to take care of it.

Dr. NOURSE. Well, that is a separate question. That is, of course, entirely true. It is not that they increase production to the full extent of their machine potential, but that certain companies will install appliances at that time and they have resources out of which to do it. I think that is one of the stabilizing factors in our economy at the present time, that large industrial concerns have a long-run program. I suppose A. T. & T. is one of the best illustrations of this long-run programing and the automobile companies also have emphasized it recently. They announce that they have a long-run program of development, which is not thrown out by the vicissitudes of boom and recession.

The CHAIRMAN. May I invite your attention to the fact that during the last depression, suppose we had had automation then, to the extent we have it now, and they had increased production, doubled it, or tripled it, or even 10 times as much. How would they have distributed that production, when there was no purchasing power to take it up?

Dr. NOURSE. That depends on the scale of operation. They would produce less and cut down.

The CHAIRMAN. In other words, that is just one factor to be considered?

Dr. NOURSE. Yes, sir. Of course, the other way of saying that is that insofar as we get a sustained high rate of productivity, the ease of assimilating technology is increased. If we have periods of recession we then do have difficulties.

Dr. BUSH. May I ask Dr. Nourse a question right along that same line?

The CHAIRMAN. Yes, sir.

Dr. BUSH. I have been told for a long time that human wants are unlimited, and hence it is impossible to saturate a market overall; that it is possible to saturate it in detail but not overall. On the other hand, I have a feeling that there is a limit to which men will work in order to secure goods and services for their needs and their enjoyment. I know quite well, personally, I might have worked hard when I was young to be able to buy an automobile, I might have worked hard even to buy a second car, but I wouldn't work to buy a third one. I would go fishing.

Now, is there anything in this matter, that if we get our production sufficiently effective, we may meet the time when human needs are beginning to be so completely satisfied that we will have a general overall saturation?

Dr. **Nourse**. I think that question goes to the very heart of our problem and touches several connections that we can bring out here. If it is economic orthodoxy that the satisfaction of human wants is insatiable, then I am a heretic. That doctrine was developed at the time we did not have and had not had in previous years a high level of productivity such as we now know. We had not been able to satisfy peoples' wants at all adequately. Now, we have made so much progress that I think the point that Dr. Bush makes is that a very considerable part of our population are getting up to the point where their further gains can be taken in leisure, with an opportunity to enjoy the automobiles, the public roads and the television sets, parks, and the thousand and one thinks that we have.

This fact of the satiability of material wants is being demonstrated currently in the suggestions being put forth by many labor leaders that their next big drive will be for more holidays, longer vacations, and a shorter workweek. A 4-day week or a 7-hour day is being discussed. This, of course, prompts the question, whose wants are nearing satiety under these new productivity rates made possible by present technology? I am moved to ask my labor friends: Are you proposing to cut down operating time because, out of a 40-hour week, you get full satisfaction and what you want next is leisure while at the same time there is a third of our population, or something of the sort, which has not been brought up to a level of consumption which is comparably in touch with the production capacity that we have? In other words, I think we don't want to take the shortening of the workweek as a way of dealing with our all-around problem of technology, consumer-satisfaction, and leisure, until we explore fully the possibilities of disseminating the benefits of the productivities we have throughout all our population.

The **Chairman**. In connection with the discussion about Russia and the United States, and about Russia being ahead of us, it was brought out yesterday, I believe, by some witness that Russia trained her engineers and technicians in the military service. They have courses of study in the military service. That is the reason that they will be able to graduate so many technicians next year. A large number of them, or most of them are in the military service.

Does that indicate to us that we should give consideration to a plan that would probably permit us to use men in the military service for that purpose?

Dr. **Bush**. I think it is an important point, Mr. Chairman. Of course, we do have in our military services now many courses of instruction, training programs, and I believe from such contact as I have had with them, on the whole, excellent ones.

Now here is an important point. I spoke a few minutes ago about the fallacy, as I conceive it to be, of taking a really outstanding youngster, who is capable of going to the top of the professon of engineering, or science, and interrupting his training period by some years in the Army. I think that doesn't make sense from a national standpoint.

The other side of it is this, and I am glad you have given me the opportunity to emphasize the other side: I have no objection whatever to drawing men generally into the military services for a period, provided their experience in the military services will be one that advances them toward their careers, and provided that the military services, when they take in, for example, a young engineer during the early part of his training, give him the opportunity to get practical experience in engineering matters, to supplement his formal studies.

Now they are doing some of this. But, in my opinion, the justification for taking technical students and scientific students into the services for a period depends entirely upon how good a job the services themselves do, while they have these youngsters, in continuing their training, in ways that have a military importance, but nevertheless have a civilian importance as well.

The CHAIRMAN. Gentlemen, we have reached the hour of 12. You gentlemen certainly have given us your time, and some very valuable information, which we appreciate.

If you would like to enlarge upon your remarks, or change them in anyway, you may do so. In the meantime, if we should want to ask you other questions in time so that you can return the answers with your testimony, your answers will also be appreciated.

The other day I placed in the record a letter I had sent to the Secretary of the Treasury Humphrey concerning this problem of automation. There were 48 engravers being displaced, and I felt like it was a good time to invite Secretary Humphrey's attention to the fact that the Government should take the lead in retraining displaced workers.

I believe it has been agreed here by all of the witnesses—I don't think there is any difference of opinion on this—that industry, the particular business and industry, should retrain their own workers and fit them right back into positions. It is the primary responsibility of the business itself to do that. I believe that is agreed by all the witnesses; and do you gentlemen agree with that?

Dr. BUSH. I agree with it, but I think that the labor unions have some responsibility and opportunity there as well.

The CHAIRMAN. That is part of business.

Dr. BUSH. Some of the men from labor organizations that spoke to you recognized this point.

Dr. NOURSE. I think also some distinction should be made there as to what sort of an industry it is. The telephone people are a striking case where they have had an expanding industry. There is greater elasticity of demand for their service. They have, by retraining, been able to absorb all their people. I think Mr. Kennedy's testimony was interesting as illustrating a different situation, where with the automation of switching yards and some other parts of the railroad system, you have people who are surplus in an industry which is not expanding.

The CHAIRMAN. There is where the difficulty is.

Dr. NOURSE. Retraining, of course, will be called for for those that they retain, but it will not enable them to retain the whole force.

The CHAIRMAN. In other words, over a long pull we expect to train people; over the short pull we have got to retrain them to fit them into the new places.

Dr. NOURSE. Yes, sir.

The CHAIRMAN. I will insert at this point Secretary Humphrey's reply, along with the press release that he got out in connection with it.

(The information is as follows:)

THE SECRETARY OF THE TREASURY,
Washington, October 26, 1955.

HON. WRIGHT PATMAN,
Chairman, Subcommittee on Economic Stabilization,
Joint Committee on the Economic Report,
Senate Office Building, Washington, D. C.

MY DEAR MR. CHAIRMAN: The attached press release explains the action taken by the Department to reduce the plate-printing force of the Bureau of Engraving and Printing. As you will note, it is due only in part to automation or modernization of the printing equipment but results primarily from the reduction in the currency requirements from 98 million sheets in fiscal year 1955 to 86 million in the current fiscal year.

As soon as it was determined that this action was necessary, arrangements were made to offer the 48 employees affected reassignments to other positions in the Bureau. While the salary rates for these jobs are substantially less than the wages they received as plate printers, the positions they were offered are permanent in nature and will give them the same opportunities for advancement provided other employees in similar positions. After considering the offers made, 31 of the plate printers agreed to accept the resassignments and 17 declined.

The curtailment of the currency-production program will provide an estimated saving of $1,350,000 a year, and is part of the administration's general policy to reduce the operating costs of the Government. It is also consistent with the expressed desires of the Congress that our currency be printed as cheaply and as perfectly as could be done in industry. You may be assured that this entire matter received my full consideration and concurrence, and I know that with these facts you will agree that it was a necessary action and one which should not be postponed.

Sincerely yours,

G. M. HUMPHREY,
Secretary of the Treasury.

[Press release, September 23, 1955]

TREASURY DEPARTMENT,
Washington, D. C.

Operating expenses of the Bureau of Engraving and Printing will be reduced an estimated $1,350,000 a year beginning November 1 through curtailment of the currency-production program, the Treasury Department announced today.

This step is in furtherance of measures instituted in the Bureau early in the present administration to improve methods and equipment so as to manufacture the Nation's currency and securities as efficiently and economically as possible while maintaining the Bureau's high-quality printing standards.

It has been determined that due to the modernization of printing equipment and the establishment of adequate inventories and stockpiles, the Nation will need only about 86 million sheets of new currency in the present fiscal year, compared with about 98 million in fiscal 1955. Some of the present inventories can safely be reduced.

The necessary cut of a million sheets in the monthly production schedule, together with a reduction in inventories where possible, will make necessary the elimination October 31 of 48 plate-printer positions, at an annual savings of about $7,700 per position. About 300 plate printers will be continued on the Bureau rolls.

The Treasury emphasized that, wherever possible, surplus personnel would be assigned to other positions in the Bureau of Engraving and Printing and in other agencies in accordance with civil-service regulations and procedures.

The economy program of the last 3 years in the Bureau has been consistent with the administration's general policy of bringing about economy in the entire Government service. This is in keeping with the expressed desire of Congress that intensive efforts be continued steadily in the Bureau to improve its equipment and processes and bring about better utilization of manpower, and with the requirement of law that the Bureau print currency and securities as safely, as cheaply, and as perfectly as could be done in industry. The program has resulted in lowering of the Bureau's operating costs by over 25 percent, with the annual savings running into millions of dollars.

The CHAIRMAN. Something else is encouraging in these hearings, I think, that not a single witness opposed automation—not one. Every one of them recognized automation as progress, and they made it very plain that they did not want to oppose progress.

Some of them had some suggestions to make, of course, as to how it should be fitted in, but none of them opposed automation.

Now this concludes this intensive set of hearings. In all, we have held 9 days of hearings, with 15 morning or afternoon sessions. These have been the first congressional recognition of this important trend called automation, which promises to have a great effect upon our lives in the future.

We will have the record of these hearings ready as soon as possible. Just when will depend in part on when we get the corrected transcripts and materials which the witnesses have agreed to supply. Other statements submitted will be included or will be made available in the committee files.

In the meantime, we expect to get out a summary report, indicating some of the conclusions and findings of this subcommittee, as reached, and a considered but limited number of recommendations.

I do not believe that we will make any direct recommendations for specific laws. I noticed that Dr. Nourse had something to say about that, and I don't think we will make any recommendations. That is just my own personal thinking. It is possible other members will have different ideas about it. I know that other members who have not been in attendance regularly are giving consideration to the testimony which we have received each day. I think that the hearings to date have demonstrated to all of us that this is an extremely important problem, and my own feeling is that under the Employment Act the Joint Economic Committee is under an obligation to be continuously alert, and if need be, hold hearings at intervals upon developments in this rapidly changing field.

Thank you, gentlemen, very, very much.

The subcommittee will stand adjourned subject to call of the Chair.

(By direction of the chairman, the following is made a part of the record:)

STATEMENT OF EDWIN M. MCPHERSON

Lester B. Knight & Associates is pleased to have the opportunity to present its views on automation to the distinguished Subcommittee on Economic Stabilization. Our firm is one of over 1,700 listed consulting firms utilized daily by industry and government to solve various problems. Consultants neither manufacture nor sell equipment, but transfer knowledge of technical advances from industry to industry, adapting the gains of one industry to the needs of another, thereby facilitating progress. It is believed that a large proportion of the recommendations of consultants lead either directly or indirectly to improved sequencing of productive effort, hence to automation in its popular context.

Consultants, in general, and we, in particular, firmly believe that American industry must make every effort to produce more goods at steadily decreasing costs. This belief, when translated into action, implies a steadily increasing investment in equipment to extend man's physical ability to manufacture goods and services. If unceasing effort in this direction is not maintained our economy will stagnate; the population increase will diffuse the standard of living, thereby reducing the overall standard for our country; and we will again face the nightmare of depression. In such a situation, labor will be robbed of its livelihood, investors of their profits, and our Government of its world leadership.

CONDITIONS LEADING TO AUTOMATION

It has been repeatedly pointed out to this committee that many of the elements of automation have been in existence in varying forms for some time. No one has clearly outlined the basic economic conditions which compel the use of these technological innovations at this time. These conditions are—

1. Purchasing power has grown, thereby increasing the size of the market beyond all prewar scales of operation.
2. The sheer volume of resultant activity has developed a series of operating problems never before faced by management.
3. Develepment of new products and processes has compelled management to reexamine their products and processes in order to survive.

It is our observation that management becomes interested in automation and that automation becomes feasible only when one or more of the following conditions exist:

1. Present and forecast demand for a product or service exceeds current capacity.
2. Present methods of accomplishing work are overtaxed.
3. Competition is affecting sales volume.

Under these conditions, management is compelled to take action which leads to continued business success, or it faces business deterioration.

CONCEPTS OF AUTOMATION

The essential difference between the present phase of man's progress and the industrial revolution which preceded it is that during the industrial revolution means for extending man's physical capacity were developed. Today means for extending man's mental capacity are being linked to these earlier devices. Electronic controls, when added to existing equipment, multiply man's productive capacity.

It has been stated that electronic devices, controlled production processes, and similar innovations replace men. This is true, but not for the reasons normally expanded upon. There are limits to the weight one man can lift, to the calculations one man can complete, to the distance a man can walk, and to the information a man can absorb. Problems were solved originally by combining units of men to accomplish an objective, such as the method used by the Pharaohs to build the Pyramids.

If we are to solve the problems of an expanding market with its multiplicity of variables, then we have to provide men with the tools to accomplish their objectives within a reasonable period of time. This means that we must utilize every means of extending man's ability to produce goods and services.

The expansion of man's activity has developed a series of bottlenecks, each of which has been solved in a manner leading to greater benefits for all. We no longer drag rock with sheer manpower to build a monument or a Chinese wall. We have developed equipment to relieve us of this physical burden.

Today we are developing means to solve a variety of new production bottlenecks. These solutions will take many forms, ranging from remotely controlled processes where electric eyes sort moving packages for shipping to devices which facilitate man's ability to process data.

Proper sequencing of operations, improved layout, use of electronic controls or installations of complex equipment normally result in increased productivity, lower reject rates on finished goods, lower costs, wider acceptance of products, and prompter customer services. Savings are derived from the combination of many elements and not from reduction of labor alone. It is just as important to management to reduce capital tied up in nonproductive inventory as it is to find a method of improving delivery by 24 hours. The savings derived from replacing one clerk with an electronic computer may often be insignificant compared to the advantage gained from developing by machine more reliable data upon which a forecast is dependent. Automation is merely one tool used to solve production bottlenecks.

EXAMPLE OF APPLIED AUTOMATION

Case I

A small mail-order house was recently faced with two problems. The number of items offered to customers for sale was steadily increasing and the number of customers accepting these offers had multiplied well beyond their original estimated.

Operations were completely manual. Customer orders were received, checked against master lists, processed and shipped with minimum mechanical aid.

In spite of the fact that the labor force had been steadily increased, orders were not being filled promptly or correctly. Management knew that if orders were not filled promptly and correctly, business would be lost to smaller competitors not faced with volume operations.

Automatic office equipment was introduced which enabled the clerical force to process orders satisfactorily through more rapid calculation of prices, extensions, and tallying of sales. Not only could more customers be accommodated but management was furnished with derivative records which permitted more accurate inventory control as well as better indicators of demand trends.

Clerical and mechanical labor costs remained approximately the same, since more skilled labor was required to operate the equipment. The total clerical force was less; reduction in force was accomplished by normal attrition.

The important point in this case lies in the fact that without installation of electronically controlled equipment, prompt service to customers would have gradually deteriorated, since it was impractical to expect humans to process the orders as rapidly as customers were demanding service. This same condition faced the Armed Forces in World War II when their supply system temporarily bogged down in unprecedented volume of fleet, shore, and airbase requirements. Today the Defense Department increasingly uses electronic equipment to process orders.

Case II

A major foundry faced with a series of problems. The number of items offered to customers had gradually increased to over 200,000, each of which required use of slightly different patterns, molds, metal mixes, etc. The production facilities were uncomfortably cluttered in spite of the erection of parallel foundry operations to reduce the workload diversity at any one plant. Reduced efficiency resulted in production delays. Mounting costs were affecting the volume of business.

The bulk of the foundry operations were completely disassociated from each other and were largely manual. Orders were scheduled in small batches on a job-shop basis. Management realized that, if these conditions continued, competitive products developed from other materials would soon price them out of business.

A study of this operation led to the first substantially automated foundry in over 6,000 years of construction. Materials were conveyed mechanically to the various points of utilization. Rigging was developed which automatically handled backbreaking jobs of pouring, shakeout, and similar heavy operations.

Today this foundry firm is in a favorable competitive position as a result of lowered operating costs. This is true in spite of the fact that new materials such as plastics often require less labor to produce.

The important point in this case example lies in the fact that without installation of electronically controlled material handling equipment and of automated rigging, new materials might well have forced an appreciable decline of business upon the foundry, with the result that a larger proportion of labor would have been displaced than was necessary under automation. Because of automation, the foundry has been in a position to increase business by producing products at lower costs, thereby stabilizing employment.

FACTORS FORCING AUTOMATION

While automation is a response to general economic conditions there are at least three drives toward automation which can be distinguished. These are (1) foreign competition, (2) increasing material and labor costs, and (3) new standards of safety.

(1) Foreign competition

Consultants have been freely employed by Government agencies to assist foreign enterprises in developing manufacturing facilities. Foreign firms which have long considered the American market and observed the production strides of American industry have also called upon consultants for assistance in developing more productive plants.

This exchange of technical knowledge is building strong competitive industry abroad. This is particularly true to Europe. The destruction of World War II in a sense has forced Europe to modernize its industry. American industry may expect increasingly keen competition from new European industrial complexes. For example, the most completely automated automobile plant in the world has just been completed in Germany. Norway, Finland, and Switzerland are in the process of building highly automated foundries. Russian engineers are building new steel facilities in India which may develop a surprising cost edge.

The difference between foreign and American installations lies in the fact that foreign labor, in general, does not participate in the benefits of increased productivity to the extent American labor does. This is one way of saying that a basic cost differential exists which permits foreign industry to outbid American industry in world markets, given equal facilities.

We are faced with the choice of subsidizing American industry to offset labor-cost differentials, as we do in the shipbuilding industry; or with developing production techniques which are always in advance of our foreign competitors. Subsidy normally leads to stagnation, since the incentive to develop new methods is removed. This problem will grow if industry fails to utilize every means to expand man's productive capacity.

(2) *Increasing material and labor costs*

American labor has asked for and received increased wages. These increases have been reflected in higher material costs and in higher consumer-item costs. Some manufacturers have discovered that they are unable to pass on increased costs to the consumer. In order to maintain volume they have sought and accepted new methods for producing items at lower costs. In doing so they have gradually shifted personnel to higher grade and more productive work by providing labor with tools that extend their capacity.

This shift has the effect of making labor's gains in wages real gains, rather than paper gains. If industry fails to develop better techniques for producing goods, then inflation will wipe out all of the immediate wage gains of labor. An example of the benefits of automation to the consumer is easily found. Take the can of beer you sometimes open in the evening. It is the end product of one of the most highly automated systems in the food industry today. Can you imagine what this can of beer would cost if it were filled, capped, and soldered by hand? Just the filling operation alone would probably raise the price a dime, let alone all the other elements. Yet automation has kept the price of this product down to where it is readily afforded. In spite of increased material and labor costs, automation is permitting wage gains accomplished by labor to be real gains.

(3) *New standards of safety*

As equipment has developed greater speeds of operation, it has become increasingly dangerous. Men have been killed or maimed by standing too close to a moving shaft. As a result of this situation remote-control devices have been developed to permit observation and operation of dangerous machinery at a distance. To some extent these devices fall within the popular concept of automation. They make decisions; they remove men from jobs at the machine; and they often reduce costs of operation by decreasing operating delays. In some areas of the world a life is still of small value. Here, I believe we can all agree, a job is of less value than a life.

AREAS IN WHICH DANGER OF STAGNATION IN OUR ECONOMY EXISTS

In every revolutionary process there are backwaters which progress seems to pass by. Each of us can call to mind a number of industries and services in which no progress is apparent. Some of these industries are already requesting Congress for assistance in the form of high tariffs, subsidies, and similar grants. If grants were made in the form of research funds to consider automation or other means to place these industries on sounder economic base, the declining competitive position of these industries could often be reversed.

We, as consultants, often undertake economic research to guide us in determining the basic nature of industrial problems. As the result of such research we can, from time to time, delineate areas of weakness in our economy. An example of an area of weakness might be of interest to this committee.

EXAMPLE

There are in our country many thousand small independent retailers and wholesalers who have traditionally fixed margins for operating their businesses. They compete with industry for labor, hence must meet the rates established by industry if they are to obtain the help they require. Their principal item of expense is labor and its cost is rising, while their margins remain fixed.

In addition to this problem, more and more desirable products are being offered the public. Distributors must increase the variety of their stocks in order to perform their function. To complicate the stock pattern more, merchandise is becoming more intricate in many instances, requiring the maintenance of a great many spare parts in order to keep customers satisfied. This in turn requires more help and increases overhead. It also requires more area for storage, which is an expense.

If we are to prevent our distribution system from deteriorating, we must develop methods for handling goods which will not require price increases. In short, we have to develop some form of an automated warehouse which permits low-cost distribution. The same type of research would be of benefit to the Government and to industry, since they have the same problem of distribution many times magnified.

This example represents only one of the problems which face our economy today. You can, without doubt, bring to mind many more. We believe that automation should be encouraged in these areas of potential danger to our way of life. The loss of our independent distributors to a State-controlled distribution system is a distinct possibility, if we fail to assist them in finding ways to meet the problems our increasingly complex society is forcing upon them.

SUMMARY

Our country is growing at a rapid rate. Income is growing with the population increase. This combination has developed a market in excess of prewar markets. The meeting of this market requires gathering and utilizing of data on a scale beyond past experience. The variety of demand, the complexity of equipment, the sheer number of items are taxing past methods of operating business beyond their capacity. A logical extension of man's mental capacity has been devised to assist us in meeting this situation.

Electronic controls in combination with mechanical devices are permitting industry to attain greater standards of safety, larger volumes of goods, and lower costs. Development and extension of these developments within industry are a basic necessity to progress. The Government should encourage business to invest in research and in greater productivity and should assist small business which lacks capital for research in solving their productivity problems. Without such progress employment cannot be stabilized and real gains in purchasing power will not be made.

Even more important, in order to extend our industrial growth, to improve our living standards, and to maintain our world leadership, we must accelerate the pace at which we are adapting technological innovations to our daily activities.

STATEMENT ON EFFECT OF AUTOMATION IN BEHALF OF MARYLAND TELEPHONE UNION, INC.

It is our understanding that your committee is interested in concrete specific case-study information concerning the effects of automation on employment, productivity, and purchasing power.

Here in the Chesapeake & Potomac Telephone Co. of Baltimore City as well as in other Bell System companies, automation is nothing new.

The telephone companies have been converting to dial operation for local calls since approximately 1930.

Conversion to local dialing has had no serious ill effects on employment due to the tremendous increase in toll calls for which operators were needed.

In other words, every local manual office that was converted to dial was at that time also converted to a toll office, handling only toll calls and customer-assistance calls.

Today, however, we have entered a new era of customer toll dialing where the customers can dial their own station-to-station toll calls, thus really eliminating the need for operators.

From 1930 to 1950, a period of 20 years, the Bell System had only succeeded in converting 45 percent of the telephones then in existence to dial operation for the purpose of customer dialing of local calls.

Since 1950 conversion of telephones to dial has been increased to 85 percent of all telephones in existence (and here we must remember that today there are twice as many telephones), besides the fact that since that time 1½ percent of all the customers (again a larger number) can dial their own station-to-station toll calls to places like New York, Washington, Philadelphia, Newark, Pittsburgh, Baltimore, San Francisco, Denver, just to mention a few, and besides the fact that the operators in the Bell System can now dial directly the telephones in 80 percent of the cities in the United States.

Incoming toll calls to the Baltimore area alone had increased to such an extent that in 1949 they were handled in a separate central office that employed 172 nonsupervisory employees. Since then because of the rapid advance in toll dialing, which allows operators in other cities to dial Baltimore area numbers directly, that force today, is reduced to 13 people.

The Laurel, Md., central office is another good example of what customer toll dialing does to employment and purchasing power. Before Laurel was converted to dial in 1954 there were 40 nonsupervisory employees on the payroll handling local calls only, through manual operation. When it was converted to dial, the Laurel customers could dial their own station-to-station toll calls to Baltimore, Washington, Frederick, Annapolis, Chicago, Philadelphia, Pittsburgh, Newark, New York, etc., approximately 12 cities altogether. In spite of the fact that the Laurel operators were then trained in toll operating and began to handle all toll calls from Laurel customers which they were unable to dial (these calls had formerly been handled by Baltimore operators) that force has been reduced to 18 people.

The most recent case of dial conversion in the Maryland area, which also carried with it customer toll dialing to approximately the same cities named previously, was that of Cumberland, Md. This office previous to dial conversion in August 1955 employed 170 nonsupervisory employees. Today that force is reduced to 88 employees.

Now the telephone company would tell you that in Cumberland they only laid off 18 people and that they offered employment elsewhere to all of the 82 surplus employees.

They would not tell you that although they offered employment elsewhere that it was in cities other than Cumberland, and those people will sooner or later be faced with the same problem when the office to which they have transferred is also converted to dial and cutomer toll dialing. They will also not tell you that the 18 people they mention were people who were hired as regular full-time employees but they also laid off 22 people who were hired as temporary full-time employees and who had been with them for over a year.

They will also not emphasize the fact that commonsense tells us they cannot continue to absorb these displaced people in other central offices as the conversion program moves forward and those offices to which they are transferring them are also converted to dial.

They will also not emphasize the fact that customer toll dialing to the few points mentioned is only the beginning and that by 1965 they expect to be able to have customer toll dialing to any point in the United States and Canada, with operators needed for only 20 percent of the toll calls now being handled. That is, for person to person, collect calls and calls from pay stations which customers are unable to dial themselves.

As for purchasing power, the loss of purchasing power in a community like Cumberland which has already been hard hit economically is tremendous and this loss of purchasing power to the community is not due to loss of business on the part of the telephone company but merely their desire for greater profits through increased productivity and less labor costs obtained through mechanization.

The telephone companies are thus continuing to take money out of these communities but are failing to help the community from which they are getting their profits by providing employment and purchasing power in the community.

There has also been no decrease in telephone rates, rather there have been increases in intrastate rates that makes it cost as much to call Cumberland, Md., from Baltimore as it cost to call Newark, N. J.

The loss of purchasing power in Cumberland in basic wages alone was $130,166 per year. This does not take into account the premium payments these people made for Sundays, holidays, overtime, shift differentials, etc.

We believe that the employees, the stockholders, and the public should share in the fruits of increased productivity obtained through automation and we believe that every corporation that is expanding through automation at a cost to consumers and stockholders has a duty to the communities in which they operate and obtain this revenue to live up to their social responsibilities and assist these communities economically. They cannot do this by cutting down on employment in these communities.

We sincerely believe the only answer is a shorter workweek but we are practical enough to know that no one individual industry is going to stick its respective neck out and lead the way. It will only be done through legislation where they are all required to do so at the same time.

Our union represents the traffic department employees of the Chesapeake & Potomac Telephone Co. of Baltimore City, throughout the State of Maryland except those in the Maryland portion of the Washington metropolitan area.

Respectfully submitted.

MARGARET C. WEISS, *President.*

STATEMENT OF ALDEN ELSTROM, PRESIDENT, ALDEN ELSTROM ASSOCIATES, MINNEAPOLIS, MINN.

I imagine that years ago when mechanization was in its infancy, people had the same apprehension about it as they do about automation today. Webster's Collegiate Dictionary defines mechanization as follows: "To replace personnel with machinery wherever possible." If one took Webster's definition literally, by now there should not be anything but a few men and many machines operating our vast American industries. But look what's actually happened, industry over the years has continued to employ more and more workers, and our economy and output have continued to expand. Why? Because of the successful application of the principles of mechanization. Today, mechanization is accepted by both businessman and worker as a commonplace thing.

The only difference between mechanization and automation is the fact that we have developed highly scientific electronic controls of many types together with mechanical, hydraulic, and pneumatic devices which will perform the services that make automation possible. Automation in its simplest form is the extension and development of techniques of mechanization which have been a part of the thinking of every businessman since the invention of the wheel. It is simply the development and use of completely automatic equipment to an entire process or machine. Perhaps a more descriptive term for this development would have been "automechanization" or "supermechanization."

I think that it is important to remember that the installation of automatic equipment in American factories is not new. It has been happening for many years and, while it has been happening, production, employment, and profits have all increased. There is no reason to believe that this trend would suddenly be reversed by the extension of the use of automatic equipment in industry.

The problem of having automatic equipment replacing employees is not as great as it might on the surface appear. Many employees who have the necessary background and experience will be trained to move into more highly skilled jobs handling automatic equipment. Others will be involved in maintaining the automatic equipment in proper working condition.

I would like to point out, too, that the trend toward automation will be a gradual one, and one which will take years to effect. For example, the replacement of certain employees by automatic equipment in a specific plant does not take place overnight. As a matter of fact, the complete changeover takes months and years to effect. To me, all this means that those involved will have plenty of time to readjust and that there will be no widespread ill effects on our economy.

At this time I would like to emphasize that many thousands of workers will be needed for a new industry—that of building the automatic equipment needed to produce automation on a broad scale. In my opinion, these new jobs will take up much of the slack created by the elimination of certain jobs where automation has been installed. Lower production costs, resulting from automation, will widen markets thereby creating additional employment because of increased sales demands.

It is important to point out, too, that the type of equipment needed to automate a process or machine in most cases today falls under the category of "special" equipment. In other words, in most cases it is impossible to purchase standard equipment and standard parts in order to automate a process or machine. Because the necessary equipment is not standard, it takes a great deal of time to produce and consequently is much more expensive. This factor, too, will contribute to a more gradual introduction in the use of automation. Because of its very nature, it will be impossible to produce standard automation equipment to any high degree.

Another item that most people seem to have lost sight of is the fact that many American businessmen will be slow to adopt automation. There are, of course, in every industry leaders who are quick to attempt to gain what they feel would be a competitive advantage over others in their field. Because of this, we may see a short spurt toward wider use of automation across the board, but I believe this will be only temporary. It will be followed by a long-term slow acceptance by the average American businessman. One of the contributing factors being the extensive investment required in most cases.

It is these "leaders" who are responsible for focusing the attention of the general populace on the overall effects of automation. Frankly, I cannot see cause for alarm. I think automation is just part of the normal development in industrial techniques. It will probably entail some shifting of employment, but it will be gradual and of the type that our economy has been undergoing for many years.

In conclusion, may I say that I think it is important to remember that advancing technology, historically, has created more jobs instead of fewer. If, as many economists anticipate, our American standard of living is doubled within the next 20 years while on the other hand we have a shorter workweek, it may result in a shortage of labor rather than a surplus.

STATEMENT SUBMITTED BY M. D. MOBLEY, EXECUTIVE SECRETARY, AMERICAN VOCATIONAL ASSOCIATION, INC.

THE ROLE OF VOCATIONAL EDUCATION IN TRAINING OF TECHNICIANS

In a period of technological advances, it is essential that a flexible program of education and training exist for the purpose of assisting in the adaptation of the working force to meet the skill and knowledge requirements of the new technology. The advent and continued development of automated industry, with its increasing requirement for skilled technicians and mechanics, is dependent upon a source of training for new workers and retraining of those already employed in the technical skills required for the installation, maintenance, and service of automated devices and electronic computers. Considerable emphasis has been placed on the apparent shortage of technicians and the evident lack of facilities for their training. Fortunately, such a source for training already exists in the public vocational schools of the Nation.

The growth of vocational education in our public schools has been a result of the ability of such programs to adapt to the changing needs of our industrial economy. As evidenced by their performance in developing war production training programs, vocational educators possess the background of experience and know-how necessary for the development of efficient technician training programs. Many vocational schools are already engaged in revising programs and offering technical training courses in response to industry's demands.

Throughout the Nation, area vocational schools and technical institutes are being established for the purpose of providing the necessary training to prepare workers for increasingly responsible jobs in industry. Labor and management representatives are assisting in the organization of technical courses in these schools through participation on advisory committees or elected school boards.

The national vocational education acts exist for the promotion and development of such training. Within their framework, classes for the preparation of technicians and the retraining of skilled workers can be established and supported even at the post high school level. The establishment of such local programs for the training of technicians of less than college grade could do much to relieve the overcrowding of engineering schools whose basic purpose is the development of professional engineers. Under the Smith-Hughes and George-Barden Acts, during fiscal 1954, over 800,000 were enrolled in trade and industrial courses. Of this number 555,133 were employed workers, including apprentices enrolled in courses supplemental to their daily employment for the purpose of improving their skills and knowledge to keep pace with technological advances. Such enrollments continue to grow as the demands for new skills increase. If industry's recognized ratio of technicians to engineers is to be achieved and if we are to keep pace with the stepped up technical training programs of Russia and its allies in maintaining a balanced world economy, the increase in the development of new programs of vocational-technical training is imperative.

In February 1955, the American Vocational Association—a professional organization of vocational teachers and officials—made a nationwide survey to determine: (1) The total number of additional vocational teachers needed; (2) the total cost for employing teachers on an annual basis at the present salary schedule; and (3) the total amount of Federal funds needed based on present percent of salaries paid from Federal funds.

Replies were received from all of the 51 States and Territories of the Nation. According to these replies, which were submitted by responsible State officials, a total of 19,015 additional vocational teachers are needed to meet present needs in federally aided vocational programs. The total cost for employing this number of teachers at the present annual salary schedule amounts to $81,107,748.56. The total amount of Federal funds needed based on present percent paid from Federal funds would be $19,976,007.56. These facts obtained from the best available source clearly indicate that there is great need for the further development of vocational education in the public schools of the Nation. Especially is there need for expanding programs for the training of technicians in an increasing number of communities. The future of America is tied inseparably with the skill, technical and scientific knowledge, and the production and distribution know-how of the masses of the people. Vocational education can continue to play an important role in the training of people that will insure the future safety and well-being of this Nation.

(Whereupon, at 12:10 p. m. Friday, October 28, 1955, the subcommittee adjourned, subject to call of the Chair.)

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